Forestry Canada Forêts Canada

Forest pest conditions in the Maritimes in 1989

Laszlo P. Magasi

Information Report M-X-177
Forestry Canada - Maritimes Region

Forestry Canada

Forestry Canada is the main focus for forestry matters in the federal government. It provides national leadership through the development, coordination, and implementation of federal policies and programs to enhance long-term economic, social, and environmental benefits to Canadians from the forest sector.

The Department is a decentralized organization with six regional forestry centres, two national research institutes, and seven regional sub-offices located across Canada. Headquarters is located in the National Capital Region.

In support of its mandate, Forestry Canada carries out the following activities:

- Administers forest development agreements negotiated with the provinces
- Undertakes and supports research, development, and technology transfer in forest management and utilization.
- Compiles, analyzes, and disseminates information about national and international forest resources and related matters.
- Monitors disease and insect pests in Canada's forests.
- Provides information, analyses, and policy advice on economics, industry, markets, and trade related to the forest sector.
- Promotes employment, education, and training opportunities in the forest sector.
- Promotes public awareness of all aspects of the forest sector.

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Forêts Canada

Forêts Canada est l'organisme principal en matière de foresterie à l'intérieure du gouvernement fédéral. Chef de file sur le plan national, il assure la préparation, la coordination et la mise en oeuvre des politiques et programmes fédéraux et environnementaux à long terme offerts aux Canadiens par le secteur forestier.

Le ministère est une organisation décentralisée: six centres de foresterie régionaux, deux instituts de recherche nationaux ainsi que sept sous-bureaux régionaux sont répartis dans tout le Canada. Le siège social est établi dans la région de la Capitale nationale.

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- il entrepren et appuie la recherche, la mise au point et le transfert technologique dans le domaine de la gestion et de l'utilisation des forêts
- il rassemble, analyse et diffuse de l'information sur les ressources forestières nationales et internationales et les domaines connexes
- il fait des relevés des maladies et des insectes ravageurs des forêts canadiennes
- il fournit de l'information, des analyses et des conseils (quant aux politiques) concernant l'économie, l'industrie, les marchés et le commerce reliés au secteur forestier
- il favorise les occasions d'emploi et de formation universitaire et technique dans le secteur forestier
- il encourage les Canadiens à prendre conscience de tous les aspects du secteur forestier.

Le ministère entretient des rapports sur une base régulière avec les gouvernements provinciaux et territoriaux, l'industrie, le monde du travail, les universités, les environnementalistes et le public par l'entremise d'organismes comme le Conseil canadien des ministres des Forêts, le Conseil consultatif du secteur forestier, le Conseil consultatif de la recherche forestière du Canada, le Comité de l'inventaire des forêts du Canada, le Comité canadien de gestion des incendies de forêt, le Centre interservices des feux de forêt du Canada et des comités consultatifs régionaux. Le ministère joue également un rôle actif dans des organismes internationaux de foresterie comme l'Union internationale des organisations de recherche forestière et l'Organisation pour l'alimentation et l'agriculture, de même qu'au sein de délégations de nature technique ou commerciale.

FOREST PEST CONDITIONS IN THE MARITIMES

IN 1989

by

Laszlo P. Magasi

Information Report M-X-177

Forestry Canada - Maritimes Region

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ABSTRACT

This report reviews the status of forest insects and diseases in the Maritimes Region in 1989 and forecasts conditions for 1990, when appropriate. Economically important pests of current concern are discussed in some detail, other organisms are listed in tabular form. A separate chapter discusses the various special involvements with related activities, such as the use of pheromones as survey tools, the Acid Rain National Early Warning System (ARNEWS), and others. A list of forest pest related publications and reports is included. More detailed information is available from Forestry Canada - Maritimes Region.

RÉSUMÉ

Ce rapport fait le bilan des insectes et maladies des arbres de la région des Maritimes en 1989, et donne un aperçu des conditions prévues pour 1990, lorsqu'approprié. Les ravageurs d'importance courante y sont traités en détail, les autres organismes sous forme tabulaire seulement. Les implications du RIMA dans des activités connexes, telles que l'usage de phéromones comme outils de relevé, le Dispositif national d'alerte rapide pour les pluies acides (DNARPA), et autres efforts, sont traitées dans un chapitre particulier. On y inclut une liste de publications et de rapports traitant de ravageurs forestiers. De plus amples renseignements sont disponibles au Forêts Canada - Région des Maritimes.

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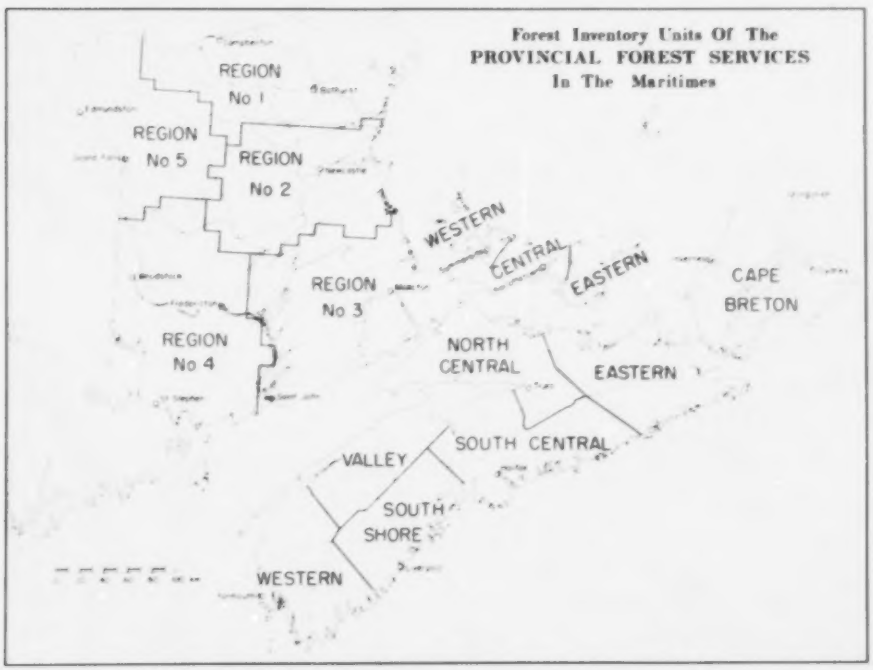
Restigouche
Madawaska
Gloucester
Northumberland
Victoria
Carleton
Kent
Prince
Queens
Kings
York
Westmorland
Albert
Cumberland
Antigonish
Cape Breton
Richmond
Colchester
Pictou
Guysborough
Charlotte
St. John
Hants
Halifax
Annapolis
Lunenburg
Digby
Queens
Yarmouth
Shelburne


Forest Inventory Units Of The
PROVINCIAL FOREST SERVICES
In The Maritimes
REGION
No 1
REGION
No 5
REGION
No 2
REGION
No 3
REGION
No 4
WESTERN
CENTRAL
EASTERN
CAPE
BRETON
NORTH
CENTRAL
EASTERN
SOUTH CENTRAL
VALLEY
SOUTH
SHORE
WESTERN

INTRODUCTION

Some of the objectives of the Forest Insect and Disease Survey are to monitor insect and disease conditions, determine their effects on the forest, and report on the status of important and common pests. In the Maritimes, this information is disseminated to interested agencies and individuals through periodic reports, such as Seasonal Highlights, Technical Notes, Information Reports, and the Annual Report of the Forest Insect and Disease Survey.

In this report, pest conditions in 1989 are described; operational control programs against the spruce budworm, Scleroderris canker, gypsy moth, spruce budmoths, Sirococcus shoot blight, seedling debarking weevil and Dutch elm disease are outlined; forest pest related research programs connected with the aims of the Forest Insect and Disease Survey are briefly mentioned; and a list of reports and publications relating to forest pest conditions is included.

This report aims to provide forest managers with information on pest conditions in the Maritime Provinces early enough that it can be considered in management decisions before the start of the 1990 field season. Insects and diseases that were widespread and caused considerable concern in 1989 are discussed in detail, others are presented in tabular form. More information on these and on other specific conditions will be provided by Forestry Canada - Maritimes Region upon request.

In the past, we have included a chapter on special surveys to report on some of our projects that have implications for forest management. In 1989, this chapter includes: a summary of plantation pest assessment surveys carried out in cooperation with the provincial forestry services and several companies; pinewood nematode, a pest of importance to international commerce and of concern to plant quarantine organizations; a summary of work on the North American Sugar Maple Decline Project; a brief statement on the status of work on pheromones and other attractants used as tools for detecting the presence and monitoring the spread and fluctuation of forest insects; and a section which deals with the Acid Rain National Early Warning System (ARNEWS).

We attempt to add background information on the pests discussed, in response to suggestions and requests from our readership, which has expanded beyond the traditional clientele of the forestry community. This will, we hope, place the organisms in a better perspective and provide readers with a clearer understanding of the concerns we express. Comments on any part of the report for improved presentation are always welcome.

Two maps are included on the page facing this introduction to help the reader locate areas mentioned. One shows the counties of the three provinces and the other indicates the provincial forest services' forest inventory subdivisions.

Efforts towards collecting and reporting information in quantitative terms are emphasized but, for a variety of reasons, it will never be possible to express all observations quantitatively. Throughout this report, the terms "severe, moderate, light, and trace" are used to describe the level of defoliation and, in some cases, other injury or insect population levels. Unless otherwise stated, the terms have the following ranges:

Trace	up to 5%
Light	6 - 29%
Moderate	30 - 69%
Severe	70 - 100%

The cover of this report illustrates Sirococcus Shoot Blight, the most serious plantation pest problem of red pine in the Maritimes, a concern in forest nurseries and a frequent problem on spruce cones.

SUMMARY

In 1989, ***spruce budworm*** caused moderate and severe defoliation of balsam fir and spruce over 396,000 ha, mostly in the northern half of New Brunswick. In central and southeastern Prince Edward Island, patches of severe or moderate defoliation of white spruce occurred over a total area of approximately 100 ha, after two years when no defoliation was reported in the Province.

There was no defoliation, for the third consecutive year in Nova Scotia. Control operations were conducted only in New Brunswick and covered some 611,200 ha. It is predicted that in 1990 infestations in New Brunswick will affect about 1.47 million hectares, of which 500,000 ha will be in the medium to high range. Population levels are expected to remain generally low in Nova Scotia with the exception of a small area in Inverness County on Cape Breton Island and possibly at isolated spots in Pictou, Cumberland, and Annapolis Counties. In Prince Edward Island, no significant outbreaks are expected, although patches of defoliation may occur in the eastern parts of the province.

Hemlock looper caused moderate and severe defoliation of balsam fir over 2,350 ha in the Christmas Mountain area of northwestern Northumberland County, N.B. The outbreak is the first ever recorded in New Brunswick since the establishment of FIDS in 1936. Indications are that the outbreak will continue in 1990 and populations may increase in other areas of the province as well. Populations were generally low in Nova Scotia and Prince Edward Island.

Spruce beetle killed white spruce in a number of areas in northwestern Northumberland County in New Brunswick, and in many areas at scattered locations on mainland Nova Scotia. Infestations decreased in Prince Edward Island and tree mortality occurred in one area only.

Eastern larch beetle populations remained generally low throughout the Region and only a few tamarack trees were recently attacked at scattered locations in all three provinces.

European larch canker was again not found outside the range of known distribution in any of the 95 areas examined in the three provinces in 1989. No new areas of infection have been found since 1986 when plant quarantine regulations were imposed on parts of New Brunswick and Nova Scotia.

Scleroderris canker was present in several jack pine, red pine, and Scots pine plantations, causing considerable lower branch damage in some. All cultures obtained in 1989 were of the North American race, including one from a plantation in Madawaska County, N.B. where the European race was identified in 1988.

Stillwell's syndrome, the sudden death of balsam fir trees, affected trees throughout New Brunswick and Nova Scotia but the number of trees that died at any given location was generally low. This syndrome was not observed in Prince Edward Island in 1989.

Armillaria root rot killed both young and old trees. The disease was found in 18% of over 300 young spruce and pine plantations in New Brunswick and Nova Scotia, generally at low infection levels. Tree mortality also occurred in silviculturally thinned stands, seed orchards, provenance trials, and natural stands.

Seedling debarking weevil has become one of the major threats to the success of plantation establishment in areas where harvesting is quickly followed by reforestation. Trials with various site preparation techniques to reduce losses are being evaluated. Delayed planting in high hazard areas appears to be a viable pest management option.

Spruce budmoths damaged an average of 13%, 11%, and 19% of white spruce shoots in New Brunswick, Nova Scotia, and Prince Edward Island, respectively. Damage occurred throughout the Region and reached a high of 68% in an area of Annapolis County, N.S. The adulticide control program in New Brunswick appears to be successful.

Sirococcus shoot blight remained the most serious plantation problem of red pine in western Nova Scotia and also caused damage in the eastern part of that province as well as in eastern Prince Edward Island and southern and eastern New Brunswick. Previously infected plantations continued to deteriorate and some of those in western Nova Scotia are virtually "wiped out". Trials indicate that sanitation measures, such as removal and burning of badly infected trees and pruning and burning of infected branches, may be a viable control option.

Pine leaf adelgid infestations affected 36% of white pine shoots, galls were formed on 17% of red spruce shoots in western Nova Scotia, an increase from the previous year. Shoot mortality of white pine was 7% in the fall with more mortality expected in the spring of 1990.

Whitemarked tussock moth populations were generally low throughout the Maritimes, and only light defoliation occurred in a few isolated areas.

Balsam woolly adelgid attacks, resulting in stem-wool and gouty twigs were found in several coastal areas in New Brunswick. In Nova Scotia, most of the affected trees were found on Cape Breton Island, where at some locations gouty twigs were present on all trees. Affected trees were observed in central Prince Edward Island.

Needle rust and leaf rusts occurred throughout the Maritimes, most at low infection levels, causing little damage. The exception was ash rust in parts of western Nova Scotia where severe and moderate foliage browning occurred and the results of repeated foliage damage were evident in the form of twig and branch dieback in some areas.

Gypsy moth was present at 11 locations in New Brunswick and at 15 locations in Nova Scotia. Most of these were areas where the insect has been known to be present, the only new locations were Milltown, Charlotte County, N.B., and Lake Paul, Kings County, N.S. The Gypsy Moth Coordinating Committee remained active in coordinating the surveys. Federal/Provincial agreements between Agriculture Canada and the provinces of New Brunswick and Nova Scotia formed the basis of control programs, that consisted mostly of pheromone trapouts. The total trapping effort in the Maritimes involved 7,263 traps, representing a 95% return of those placed.

Oak leafroller and ***oak leaf shredder*** caused serious defoliation of oak over 8,200 ha in western Nova Scotia (mainly leafroller), in a few localized areas of New Brunswick (mainly leaf shredder), and in Prince Edward Island (both species). The outbreak in Nova Scotia decreased from 1988 in both area affected and intensity. Deterioration of stands continued however, and only 1% of over 1,000 trees assessed were classified as healthy in 1989.

Pear thrips, an early defoliator of hardwoods, especially of sugar maple, which caused widespread concern over much of the north-eastern United States last year, was found for the first time in the Maritimes on sugar maple, in five widely separated areas in New Brunswick. More surveys are needed to establish the distribution of this insect in the Region.

Other hardwood defoliators were generally "quiet" in 1989 and caused only local concern. They are included in the summary table in the report with pertinent remarks.

Birch casebearer populations increased significantly in Prince Edward Island, decreased in Nova Scotia, and remained stable in New Brunswick. Average foliage browning of white birch was almost 50% in P.E.I., 20% in N.B., and 13% in N.S. Wire birch and yellow birch were also affected to some extent.

Birch leafminer caused severe foliage discoloration of wire birch in a few areas in Nova Scotia, leaf browning elsewhere was light or moderate in the Province. Populations were low in New Brunswick and Prince Edward Island, causing only trace to light discoloration in most places.

Birch skeletonizer was again widespread in Nova Scotia and caused extensive foliage browning of white birch, especially on Cape Breton Island and northern Antigonish County.

Larch casebearer was much more common than during the past few years and caused severe or moderate foliage discoloration in many areas, mostly in Nova Scotia and western Prince Edward Island.

Poplar serpentine leafminer outbreaks continued in northern New Brunswick, affecting an average of 61% of the foliage on 98% of the trees. As a result of repeated severe attacks, leaves of trembling aspen are smaller than normal, trees appear generally unhealthy, and twig dieback is

evident in some areas. Populations are lower in southern New Brunswick and generally very low in Nova Scotia and Prince Edward Island.

Wind damage caused extensive, severe or moderate leaf browning along a coastal strip in Cape Breton Island, affecting approximately 20,000 ha of hardwood forest at the end of June.

Maple decline studies in 1988 indicated that 80-100% of trees in permanent plots in New Brunswick had no more than 10% dieback; in Nova Scotia, there was some decline in tree condition on some of the plots between 1988 and 1989, but most sugar maple trees were in very good condition.

Dutch elm disease intensified within the known area of distribution but did not spread significantly in any of the three provinces.

Seed orchard insects and diseases were numerous and, although most caused little damage, any loss in these high value areas is of concern.

Nursery and Greenhouse problems were mostly abiotic in nature and resulted in the death of millions of seedlings.

Balsam gall midge populations remained low but increased considerably in distribution and intensity over last year's levels. A few spot infestations caused severe or moderate needle damage in New Brunswick and Nova Scotia.

Balsam twig aphid generally caused only light shoot damage but was common throughout the Maritimes at population levels which increased in Prince Edward Island, decreased somewhat in Nova Scotia, and remained about the same as last year in New Brunswick. Moderate damage occurred in a few isolated areas.

The ***Acid Rain National Early Warning System*** program continued in 1989 with assessment of conditions on all 17 ARNEWS plots and determination of foliage retention on over 370 locations throughout the Maritimes. Leaf browning of white birch occurred again along the Bay of Fundy in both New Brunswick and Nova Scotia. Similar symptoms were observed on white birch in numerous other areas of the two provinces. Yellowing of white spruce foliage occurred again at Loch Katrine, Antigonish County and the affected area appears to be increasing in size. Red spruce condition was reassessed on the four permanent plots.

Pinewood nematode has been identified at 27 of 228 locations, from 32 of 418 trees sampled between 1985 and 1989. All infested trees were dead pine, fir or spruce, and all were killed by other factors. The positive locations are distributed in New Brunswick and Nova Scotia. No pinewood nematode has been found in Prince Edward Island. A vector survey in 1988, involving almost 1,700 specimens in 260 collections from 151 locations, failed to identify pinewood nematode in any of the insects.

Cooperative, multi-agency ***plantation pest surveys***, including federal and provincial forestry services and industry, were conducted in the Maritimes. There were 908 plantations and 14 thinned areas assessed, involving some 35,000 trees. Most trees were classified as healthy but, in a number of plantations, forest pests were found at moderate or severe levels.

Pheromone surveys, under development as predictive tools, were carried out for spruce budworm (an international, inter-regional research effort), forest tent caterpillar, jack pine budworm, European pine shoot moth, oak leafroller, oak leaf shredder, spruce coneworm, fir coneworm, seedling debarking weevil, and gypsy moth.

Light traps were operated at 16 locations in the Maritimes, many by cooperators, and capture-results, along with other information, aided in forecasting insect populations for 1990.

Other insects and diseases encountered in 1989 but not discussed in detail are presented in tabular form with remarks.

A list of 25 publications dealing with forest insects and diseases, authored or co-authored by staff

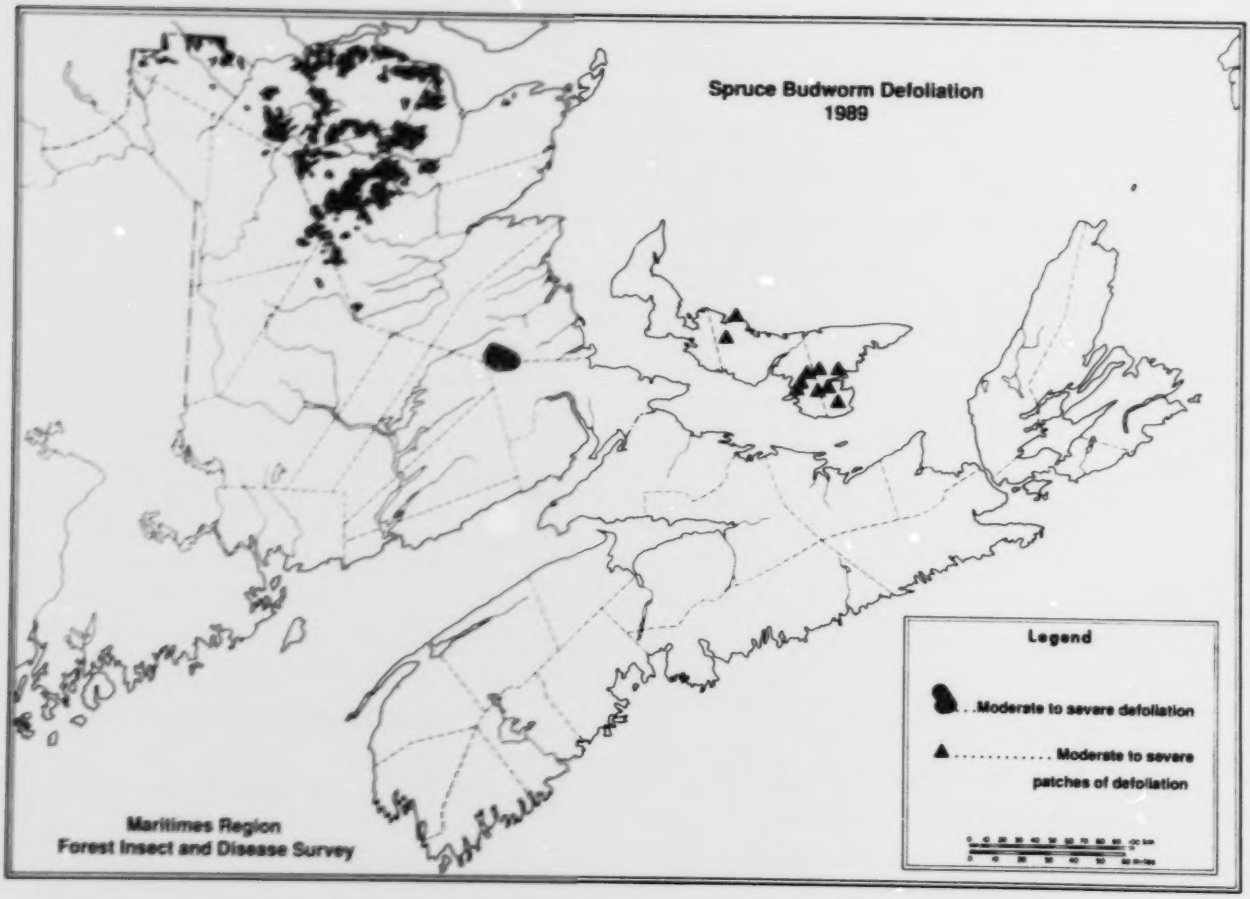


Figure 1

from Forestry Canada - Maritimes Region, is included for reference.

IMPORTANT AND CONSPICUOUS FOREST PESTS

SPRUCE BUDWORM

Information presented on the spruce budworm, *Choristoneura fumiferana* (Clem.), is summarized from various sources: New Brunswick Department of Natural Resources, Forest Protection Limited, J.D. Irving Limited, Nova Scotia Department of Lands and Forests, and Forestry Canada - Maritimes Region. Both published and unpublished data were used with permission, and the cooperation of all organizations is acknowledged. More detailed information is available from the various sources.

Spruce budworm populations have shown a marked downward trend in eastern North America during the last few years and, although the insect is still one of the major defoliators in the fir-spruce forest, the area of defoliation is generally declining.

New Brunswick

Defoliation of balsam fir and spruce stands was recorded in 463,000 ha in the Province in 1989 (Fig. 1). Defoliation was severe on 267,000 ha, moderate on 129,000 ha and light on 67,000 ha. The 396,000 ha of severe and moderate defolia-

tion was about 20% less than the 500,000 ha recorded in these categories in 1988 and less than the 430,000 ha recorded in 1987.

Most of the severe and moderate defoliation occurred again in the northern half of the Province but, while last year's infestations appeared to have broken into several patches, large areas were also defoliated further to the south, reaching into northern York County. The area in southeastern New Brunswick, straddling the Kent and Westmorland county line, was comprised mainly of unhealthy spruce stands (many dead and dying trees) indicating repeated defoliation.

Damage - There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in New Brunswick in 1989.

Control operations - Foliage protection against the spruce budworm in New Brunswick was conducted over 611,200 ha in 1989: 576,900 ha by Forest Protection Ltd. and 34,300 ha by Forest Patrol Ltd., a subsidiary company of J.D. Irving Ltd.

Forest Protection Ltd. treated 576,900 ha of forest in 1989. Of this, approximately 472,000 ha were treated with fenitrothion (Sumithion®) and 105,000 ha with the biological insecticide *B.t.* (Futura XLV®). The rates of application were 210 g/ha for fenitrothion and either 15 BIU/ha or 30 BIU/ha for *B.t.* About 62% of the treated area received two applications.

Forest Patrol Ltd. treated 34,300 ha of forest in 1989. Of this, approximately 31,600 ha received two applications of fenitrothion (Sumithion®) at the rate of 210 g/ha/application, 2,100 ha received a single application of *B.t.* at the rate of 30 BIU/ha, and the remainder (2%) received a single application of fenitrothion followed by an application of "Matacil rinse", at the rate of 3.5 l/ha.

Forecast is based on overwintering larval (L2) surveys conducted by the New Brunswick Department of Natural Resources. The prediction for 1990 is for a total area of infestation by the spruce budworm of over 1.47 million hectares. Of this, 500,000 ha are expected in the medium to high infestation categories and 970,000 ha to be 'variable', mostly at the light to medium range.

Nova Scotia

Defoliation - For the third consecutive year, there was no defoliation of balsam fir or spruce during the annual spruce budworm aerial survey in Nova Scotia in 1989. Because of indications during preliminary detection flights only an abbreviated version of the regular aerial survey was conducted. Spruce budworm populations were extremely low, no defoliation of any level was noted during ground surveys and larvae were almost impossible to locate. The only reported defoliation occurred on one ornamental blue spruce tree in Glace Bay, Cape Breton County and on a group of three ornamental white spruce trees in Dartmouth, Halifax County.

Damage - There were no specific spruce budworm damage surveys conducted in Nova Scotia by the Forest Insect and Disease Survey in 1989.

Control - No control measures on an operational scale were carried out against the spruce budworm in Nova Scotia in 1989.

Forecast - The overwintering larval (L2) survey was conducted by the Nova Scotia Department of Lands and Forests, with sampling assistance from Bowater-Mersey Ltd. personnel. Information from 240 sample locations indicates that while spruce budworm populations remain either negligible or low at 94.6% of these locations, some population increases are present. The most significant of these occurred on Cape Breton Island where in Inverness County 4.3% of the sample locations harbor extreme, 8.7% high, and 22% moderate L2 populations. Some defoliation can be expected in 1990 in this area. Additional moderate populations were also noted at four locations in Pictou County, two locations in Cumberland County and at one location in Annapolis County, the first two of these representing an increase, while in Annapolis County the moderate location is a reduction from the 12 such observations in 1988.

Prince Edward Island

Defoliation - Noticeable defoliation, mostly of white spruce, occurred in 1989, following two years when no defoliation was observed on balsam fir or spruce during aerial surveys. The total area of severe and moderate defoliation was approximately 100 ha, observed during combined aerial and ground surveys, and occurred in isolated patches (Fig. 1) in Queens and southeastern Kings Counties. White spruce defoliation was severe in parts of Prince Edward Island National Park and at Orwell in Queens County; moderate at Breadalbane, Uigg, and near Eldon, Queens County, and near Pooles Corner, Georgetown, St. Peters Road and Brooklyn, Kings County. Light defoliation was also noted at several scattered locations in the two eastern counties. Balsam fir was virtually unaffected in 1989.

Damage - There were no specific spruce budworm damage surveys conducted in Prince Edward Island by the Forest Insect and Disease Survey in 1989.

Control - No control measures on an operational scale were carried out against the spruce budworm in Prince Edward Island in 1989.

Forecast - The survey of overwintering larvae (L2) was conducted by Forestry Canada - Maritimes Region at 41 locations. Populations were moderate at 5%, low at 75%, and nil at 20% of the locations sampled. These population levels are lower than those obtained in 1988. However, over 12,200 spruce budworm moths were captured in the light trap at Kilmuir, Kings County, for the highest catch in the Maritimes in 1989. Results indicate that, although widespread outbreaks are not to be expected in 1990, small areas of defoliation may occur in the southeastern part of the province.

HEMLOCK LOOPER

Hemlock looper, *Lambdina fiscellaria fiscellaria* (Gn.), contrary to its name, is mainly a defoliator of balsam fir in the Maritimes, capable of causing serious damage when populations are high. It feeds on needles of all age classes and is a wasteful eater. Larvae chew off but do not completely consume needles, consequently a much greater amount of foliage is removed than is necessary for their development. It also feeds on foliage of various hardwoods.

In the Maritimes, populations have been generally low in the past few years. The last serious outbreak occurred in central Prince Edward Island in 1977 and 1978 when the insect killed 80% of the merchantable balsam fir and over 90% of the hemlock in the affected area. In 1988, populations of hemlock looper were low throughout the Maritimes. Only one larva was collected in New Brunswick. In Nova Scotia, only trace defoliation occurred in Cumberland County, while light defoliation occurred in Kings County, Prince Edward Island. Light trap catches were somewhat higher than in 1987 in southern New Brunswick and in the two National Parks in Nova Scotia.

In 1989, in New Brunswick, severe and moderate defoliation of balsam fir occurred as a result of a serious infestation of hemlock looper in the Christmas Mountain area of northwestern Northumberland County (Fig. 2). The infestation covered the area from Logan Lake northward to Little South Branch Nepisiquit River, a distance of 20 km, and was about 4 km wide at its widest point. Joint surveys between the Forest Insect and Disease Survey and the provincial Department of Natural Resources established that the total area of defoliation was 3,800 ha, of which 150 ha was severe, 2,200 ha moderate, and the remaining 1,450 ha light and trace defoliation. This is the first serious outbreak in the Maritimes since 1977-1978 when the insect killed large numbers of trees in Prince Edward Island. There has never been a recorded hemlock looper outbreak in New Brunswick since the establishment of the Forest Insect and Disease Survey in 1936. Insect survival was good in this area, as indicated by the large numbers of moths in the early fall, and the infestation is expected to continue in 1990. Populations may also increase in other areas of New Brunswick. Larvae were collected in York, Queens, Westmorland, and Albert Counties; almost 24% of the 509 gypsy moth traps in forested areas of western Charlotte County captured hemlock looper moths (0.53 moths/trap); 17 hemlock

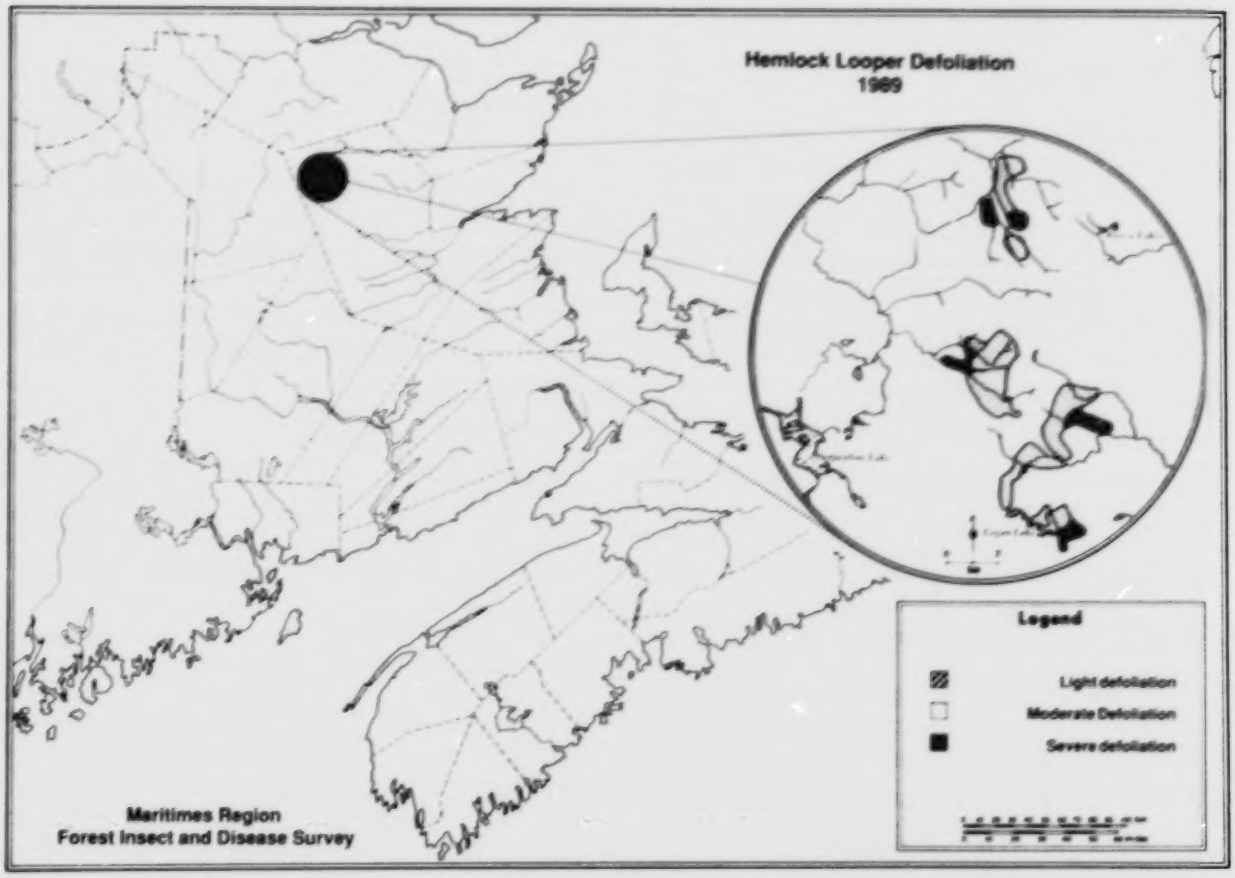


Figure 2.

looper moths were found in three spruce budworm pheromone traps along the Mountain Road, York County; and hemlock looper catches were higher than last year in all six light traps, the increases more pronounced in the southern half of the Province. The most dramatic increase in a light trap was recorded at Mayfield, Charlotte County, where 611 moths were caught, compared to the 66 moths in 1988 and 7 in 1987.

In Nova Scotia, trace defoliation was observed on a few trees at Diligent River, Cumberland County, in the area where defoliation of balsam fir was moderate and severe in 1987 and where a small outbreak has persisted since 1985. A few larvae were collected elsewhere in the province and 20 moths were captured in six spruce budworm pheromone traps at two locations on Cape Breton Island and a significant increase was noted in the light trap catches on Cape Breton Island and in Kejimkujik National Park.

In Prince Edward Island, moderate and light defoliation of larch occurred in the Camp Tamawaby Demonstration Woodlot in Prince County and larvae were found but no defoliation occurred on balsam fir in the same area. A moth-flight was observed in this area on August 23, indicating good survival and the possibility of defoliation in 1990. The insect was also found in two other areas of Prince County, on balsam fir at Greenmount and on white spruce in the Foxley River Demonstration Woodlot. Light trap catches were higher in Prince County than in 1988 but still lower than 1987.

BARK BEETLES OF CONIFERS

Not as conspicuous as some defoliators, bark beetles are nonetheless an important group of forest insects causing tree mortality. Bark beetles usually attack trees that have been weakened by other factors but, when populations are at outbreak levels, healthy trees are also successfully attacked and may be killed.

Spruce Beetle, *Dendroctonus rufipennis* (Kby.) remained active throughout the Region in 1989 and white spruce mortality occurred in all three provinces.

In New Brunswick, spruce beetle damage was reported in 1980 after a 50-year period of inactivity. Since then, the insect has been found in a number of widely separated areas, mostly in the southeastern and northwestern parts of the Province. Spruce beetle populations declined sharply in 1988 from levels of previous years and no newly infested trees were found at any of the known infestation areas, including those with the longest history; only a single infested tree was found in Restigouche County.

In 1989, spruce beetle activity increased sharply and both dead and newly infested white spruce trees were observed at a number of locations in the Meridian Brook area and in the Christmas Mountain range in northwestern Northumberland County. These infestations appear to have started near the bottom of brook valleys and are now spreading upward along the valley slopes. Other nearby valleys may also be similarly affected but access is poor and ground observations are difficult. A few newly infested trees were found along the Shepody Road in Fundy National Park and at Cains River, Sunbury County.

In Nova Scotia, Cape Breton Island constituted the major outbreak area during the early part of the 1980s and, by the end of 1983, no large areas remained without severe white spruce mortality. Beetle activity decreased between 1984 and 1986 on Cape Breton Island, but there was an increase in the number of spruce beetle-attacked white spruce on the mainland. The level of insect activity remained the same in 1987 and 1988, with most of the tree mortality occurring on Cape Breton Island and on the northern mainland. However, trees were also dying in small, scattered pockets in other areas of the Province.

In 1989, white spruce mortality, caused by new infestations, decreased on Cape Breton Island; however, there was an increase on the mainland. Most of the damage, averaging 30% in the stands examined, occurred in Antigonish, Pictou, Kings, and Annapolis Counties but small, scattered pockets of infested trees were also observed in Colchester, Digby, Lunenburg, Queens, and Inverness Counties. In a small stand of mature red spruce severely weakened by dwarf mistletoe attack near Liverpool, Queens County, 32% of the trees are dead or dying and a further 14% are infested by the spruce beetle.

In Prince Edward Island, spruce beetle killed an estimated one-third of the merchantable white spruce by 1983, when infestations peaked. Populations then have decreased steadily and in 1986 only a very few newly infested white spruce trees were observed in the Province. There was an increase in infestations in 1987 and a further increase in 1988.

In 1989, populations have apparently decreased and newly infested white spruce trees were found only at Caledonia, Kings County where, in a 20 ha stand, about 5% of the trees were freshly attacked in addition to 5-10% of the trees already dead. Old-dead trees were observed in other areas.

Eastern Larch Beetle, *Dendroctonus simplex* Lec., normally attacks only weakened, damaged, or recently felled host material. However, at very high populations, living, apparently healthy, mature or overmature trees, and even younger, small diameter trees, can also become infested.

In the Maritimes, a population buildup was first noticed in Nova Scotia in 1976. This increase in the beetle population followed several years of severe defoliation of larch by the larch sawfly, *Pristiphora erichsonii* (Htg.). Since then, the beetle has become widespread in all three provinces and has caused serious tree mortality. By the end of 1981, an estimated 24% of merchantable-size

larch was dead in New Brunswick, 64% in Nova Scotia, and 13% in Prince Edward Island. The insect populations have been generally declining since 1984 and the number of trees succumbing to beetle attack has also decreased in most areas.

In 1989, populations of this bark beetle remained generally low and few trees became infested or died as a result of attack. The exception was a small outbreak on the campus of the University of New Brunswick at Fredericton, N.B., affecting about 40% of the larch trees and resulting in a sanitation cut. Elsewhere a few mature and over-mature trees became infested and some died in scattered areas in St. John, Westmorland, and Victoria Counties in New Brunswick; in Cumberland, Hants, and Annapolis Counties in Nova Scotia; and at three locations in Prince County in Prince Edward Island.

Two trees became infested and two trees died at the central New Brunswick research plot in 1989. The infestation rate of 1.9% in 1989 contrasts with the peak year of 1987, when the infestation rate was 7.6%. Cumulative larch mortality due to attack by the eastern larch beetle has increased from 6% in the spring of 1979, when the plot was established, to 41% in 1989, an average of 3.2% annual tree mortality during those years. (Total tree mortality reported here is lower than mortality reported last year for 1988 and is the correct figure. A recalculation of the data necessitated this change).

CANKERS OF CONIFERS

Cankers are caused by many fungi, the attacks of which are manifested in different ways. However, all are similar in one important aspect: they damage trees. Damage ranges from the loss of a few small branches, or minor stem infections, to the deformation of the stem to such an extent that it becomes of little or no value, or to death. Damage in stands is also variable. Some canker diseases eliminate only a few trees, while others may spread and infect most or all of the trees in a stand or plantation. Losses are both direct, such as mortality or reduction in wood value, and indirect, such as low quality trees occupying valuable space or affected trees serving as sources of infection either to other trees in the same stand or to areas nearby.

European Larch Canker, caused by the fungus *Lachnellula willkommii* (Hartig) Dennis, has been a serious disease in many parts of Europe. The fungus is considered, by most, to be a primary pathogen (capable of infecting vigorous, healthy trees) and its presence has resulted in the exclusion of larch from plantation programs in parts of Europe. In North America, the fungus was first found in Massachusetts in the 1920s in European larch plantations. Periodic concentrated eradication attempts appeared to have been successful as the disease was not found during surveys of the area in 1965. However, it was discovered in northeastern Maine in 1981.

In Canada, the European larch canker was first discovered in the Maritimes in 1980. Surveys since then have established the distribution of the disease as widespread in southeastern New Brunswick and on mainland Nova Scotia. As a result, in 1986, the Plant Health Division of Agriculture Canada imposed a quarantine directive restricting the movement of larch material from a quarantine zone which encompasses the southern and southeastern parts of New Brunswick, south of the St. John River, in the west and south of the Miramichi River in the east and all of mainland Nova Scotia. This quarantine zone is well in excess of the known distribution of the disease. (See Figure 2 of the 1988 FIDS Annual Report, Magasi 1989). Extensive surveys, conducted annually in all three provinces and involving over 500 locations since 1983, failed to extend the known distribution of the disease as established in 1981-82. The few minor adjustments which occurred were mostly in Nova Scotia and involved gap-filling along the peripheries.

In 1989, the disease was not found at any of the 101 locations surveyed outside the known distribution, 29 in New Brunswick, 64 in Nova Scotia and 8 in Prince Edward Island. Of 10 locations examined within the known range in New Brunswick, the disease was found at two locations; 80% of the trees were infected at Vinegar Hill, Kings County and 72% at Lepreau Falls, St. John County. In Nova Scotia, the disease was

found at three locations within the known distribution: 10% of the trees were infected at Upper Rawdon, Hants County, 7% at Chaswood, Halifax County, and 3% at West Gore, Hants County. Surveys in 1988 and 1989 included the examination of 28 plantations of eastern, European, Japanese and Siberian larch, all of which were found free of the disease.

The fungus mostly infects young trees and, therefore, future wood supplies may be affected. Tree mortality reduces stocking, branch mortality reduces growth, and cankers reduce wood quality. The extent to which the disease will cause damage in the Maritimes is not yet known but the potential for damage is there and the role of the disease will have to be considered in view of increased emphasis on forest renewal and larch tree improvement programs.

Investigation of several aspects of the behavior of the fungus under our climatic conditions has been initiated. Results are reported as they become available. A survey to establish age and spread pattern indicates that the fungus could have been present in the Maritimes for about two decades before its discovery and may have spread from specific areas. The study also showed a rapid decrease in incidence of infected trees with increasing distance from the Bay of Fundy, possibly indicating a climatic dependence.

The disease is capable of intensifying rapidly in young stands. Incidence of infected trees in a research plot increased as follows, based on fall assessments: 1982 - 7%; 1983 - 19%; 1984 - 46%; 1985 - 88% and 1986 - 91% of trees affected. Considering the high level of incidence, this study was terminated.

To test differences in susceptibility to infection, greenhouse-grown seedlings of *Larix decidua, L. leptolepis, L. eurolepis, L. laricina,* and *L. sibirica* were successfully planted in a heavily infected area in the early summer of 1983. *Larix occidentalis* seedlings were added to the test in 1985. By the fall of 1987, 13 of the 24 living larch populations had at least one seedling infected and only *L. sibirica* and the late addition *L. occidentalis* were still disease free.

Scleroderris Canker, caused by the fungus *Gremmeniella abietina* (Lagerb.) Morelet, was first found in the Maritimes Region in 1971. The disease is widespread in New Brunswick, especially in the northern half of the Province and infects mostly plantations of jack, red, and Scots pine. In Nova Scotia, where the disease was first found in 1972, a few plantations of red, jack, and Scots pine suffered limited lower branch mortality during the mid-1970s. The disease was last found in that Province in 1978 and appears to have died out. It has never been found in Prince Edward Island.

After some years of minimal activity, there was an upsurge of new infections in New Brunswick in 1987, likely the result of the ideal weather conditions (wet and cool) during the infection period in 1986. In 1988, the disease was found in a few plantations of jack pine, red pine, Scots pine, and in a jack pine seed orchard. All of these, except for a Scots pine Christmas tree plantation in Madawaska County (discussed below), were found to be of the North American race.

In 1989, several jack pine and red pine plantations were found infected in the Deersdale area of Carleton County, damage to lower branches being extensive in some of these. The disease was also present in several Scots pine plantations near Bourgoin, Madawaska County in the vicinity of the plantation from where in 1988 a sample was identified as the European race. All cultures tested for race separation in 1989 were of the North American race. (We thank the staff of Forestry Canada - Quebec Region for carrying out the testing.)

To determine whether the European race of Scleroderris canker, found at Bourgoin in 1988, could have originated on infected nursery stock, the New Brunswick Department of Natural Resources inspected 20 Scots pine Christmas tree plantations in Madawaska, Victoria, Carleton, York, Charlotte, and Kings Counties, established with seedlings from the same nursery in 1976, 1977 or 1978. In addition, 14 red pine plantations, established with seedlings from the same nursery during the same time period, were also examined in those counties. The only infected plantation found was also in Madawaska County, at Baker

Brook, but the fungus was identified as the North American race.

In Nova Scotia, red pine, Scots pine, white pine, and lodgepole pine plantations, which were infected in the early to mid-1970s were re-examined in Cumberland, Halifax, Pictou, and Guysborough Counties in 1989. No evidence of Scleroderris canker was found in any of the plantations.

The European race of Scleroderris canker is capable of killing trees of any size (the North American race kills only small trees). This, and several other "intermediate" races, have been found in New Brunswick at 11 locations between 1978 and 1981. The disease had been eradicated at 3 of the 11 locations even before the final race identifications were available. "Controlled" status has been achieved by pruning branches to 2 m from the ground at two locations, one in 1985 and one in 1987. In 1988, two more plantations in northeastern New Brunswick were brought under "control" by pruning (locations 1 and 3; c.f. 1987 annual report), the work being done by the Department of Natural Resources. The remaining four locations (c.f. 1987 annual report) are "under surveillance", in that an annual inspection is conducted for symptoms and changes in symptom expression. The non-North American race of the fungus has not been found at any of these locations since 1981.

The European race of *G. abietina* was identified at Bourgoin, Madawaska County, in 1988 in a Scots pine Christmas tree plantation. In 1989, additional sampling was conducted in this plantation and in plantations in the vicinity. Only the North American race of the fungus was found.

STILLWELL'S SYNDROME
(Sudden death of balsam fir trees)

Stillwell's Syndrome, a condition of balsam fir, occurs when trees, usually with a fair complement of foliage, despite having been exposed to varying amounts of defoliation by the spruce budworm for several years, turn bright red and die. This phenomenon has been known to occur in balsam fir stands where considerable damage or mortality has occurred. The "dropping out" of surviving trees in spruce budworm damaged stands during the apparent recovery stage, even years after the collapse of the outbreak, has been referred to as Stillwell's Syndrome since 1982, when the Forest Insect and Disease Survey first drew attention to this condition.

Balsam fir trees stressed by repeated spruce budworm defoliation are susceptible to attack by numerous organisms that are normally considered to be secondary in nature, among them Armillaria root rot and several species of beetles such as balsam bark weevil, balsam fir bark beetle, and sawyer beetle.

Sudden death of balsam fir trees was reported in 1980 and 1981, from various parts of New Brunswick. In 1982, an unusually high number of balsam fir trees died in this manner and some areas of Nova Scotia were affected. The condition was present but much reduced in 1983, increased again in 1984 and continued in 1985, especially in the northwestern part of New Brunswick. The problem continued to intensify in New Brunswick in 1986 and literally thousands of balsam fir trees with bright red foliage were observed during early summer aerial surveys in the western part of the Province. The number of trees with Stillwell's Syndrome was greatly reduced in 1987 in New Brunswick and Nova Scotia, although affected trees were found throughout these provinces. No affected trees were observed in Prince Edward Island. The number of trees affected by Stillwell's syndrome was generally low in 1988, but mortality occurred throughout the three provinces. The distribution of newly killed trees was very uniform in New Brunswick; dead trees were most numerous in Colchester and Cumberland Counties in Nova Scotia, in the area of the most recent spruce budworm outbreak; and some trees were killed in all three counties in Prince Edward Island, most notably in an area of about 10 ha at Iris, Kings County, where hemlock looper has defoliated trees in recent years.

In 1989, the number of trees affected was generally low although tree mortality occurred throughout New Brunswick and Nova Scotia. In New Brunswick, less than 5% of the balsam fir trees were killed at any one location except in the south-

Table 1. Armillaria root rot in spruce and pine plantations in New Brunswick and Nova Scotia in 1989.

Plantations/Infection	Host	New Brunswick	Nova Scotia
No. of plantations assessed	Spruce	187	42
	Pine	68	14
Percent of plantations affected	Spruce	22	21
	Pine	7	7

western part of the province where 16% of the balsam fir was recently dead at Little John River, York County and 12% died at Seven Mile Lake, Charlotte County. In Nova Scotia, dead balsam fir trees were still more prevalent in Colchester and Cumberland counties than in other areas of the Province. No Stillwell's Syndrome affected trees were observed in Prince Edward Island.

ARMILLARIA ROOT ROT

Armillaria Root Rot, *Armillaria mellea* (Vahl ex Fr.) Kummer, a disease of a wide variety of tree species of various ages, has always been a part of the forest disease complex in the Maritimes, however, its significance appears to have changed in recent years. For one thing, the fungus is strongly implicated among the group of secondary organisms that combine to provide the final blow to trees weakened by other factors such as repeated defoliation by the spruce budworm. For another, Armillaria infected or killed trees are becoming more frequent throughout the Maritimes, and are often observed in plantations. The increased frequency is doubtless a factor of the increase in the area planted. The implications of the root rot for the future of plantations under our climate are poorly understood. However, the disease is killing trees in plantations. In some areas, groups of trees are affected and there is evidence that with the spread of the fungus these patches could increase in size. In other areas, only scattered trees are infected but these could become centers of infection if the fungus spreads. Not all infected trees die, (the fungus is primarily a wood decay organism causing root and butt rot), but its action may cause understocking in both plantations and natural stands.

The disease is widely distributed in the Region and mortality of trees, both young and old, was again common in 1989.

In New Brunswick, Armillaria root rot killed at least some trees in 18% of the 255 spruce and pine plantations surveyed (Table 1). Infection rates are generally low, mostly in the 2% to 8% range, with higher incidence in occasional plantations. Spruce plantations appear to be more vulnerable to the disease than pine plantations. This difference has been consistent since plantation surveys have been conducted. Armillaria root rot also caused tree mortality in other forest situations. Mature and semi-mature balsam fir, black spruce, red spruce, and white spruce were affected and infection was also found in a thinned area. The highest level of tree mortality was recorded in a semi-mature mixed stand at West Branch, Kent County, where 28% of the balsam fir and 8% of the red spruce trees were killed.

In Nova Scotia, Armillaria root rot killed at least some trees in 18% of the 56 spruce and pine plantations assessed during regular surveys (Table 1). Infection rates are generally low, mostly in the 2% to 8% range, with higher incidence in occasional plantations. An additional 17 infected spruce or pine plantations were found among the 599 plantations surveyed by staff of Scott Worldwide Inc. This incidence (2.8%) is much lower than the 18% found during the regular surveys, however, these plantations were much older than most of the other plantations and this may explain the apparent difference. Scattered trees were also killed in natural stands throughout the Province. Armillaria root rot affected 4% of the black spruce trees in a provenance trial at Little

Table 2. Armillaria root rot - spread of disease in plantations 1983-1989

Species	Year planted	Year plot est.	Former Cover type	Mortality (%) 1983	1984	1985	1986	1987	1988	1989
Black spruce	1976	1983	Softwood	8	10	10	10	--	--	--
Black spruce	1973	1983	Softwood Hardwood	4	4	4	4	--	--	--
Black spruce	1978	1983	Softwood Hardwood	8	12	20	20	--	--	--
Black spruce	1980	1983	Softwood Hardwood	8	16	24	24	24	26	28
Jack pine	1978	1984	Softwood Hardwood	-	2	2	2	--	--	--
Jack pine	1981	1984	Softwood Hardwood	-	2	4	4	6	8	8
Jack pine	1978	1984	Softwood Hardwood	-	2	2	2	--	--	--
Black spruce	1980	1985	Softwood Hardwood	-	-	2	2	4	4	4

Como Lake, Halifax County, and 3% of the trees in a black spruce seed orchard at East Mines Station, Colchester County.

In Prince Edward Island, Armillaria root rot was not found in any of the three plantations assessed in 1989.

Plots established in plantations to study the spread of the disease on different hosts and under different conditions, have been assessed annually since 1983. The plantations are of different ages and were established in areas of somewhat different cover types. A summary of observations is presented in Table 2. Only the three youngest plots were assessed in 1989 and intensification was observed in only one of the three plots. Trees in older plantations are said to acquire some resistance to fatal attack by Armillaria root rot, which they retain as long as they are in a vigorous condition without significant stress. Some of our study plantations are reaching this age. These plots will be observed annually but, unless conditions change significantly, will be assessed only on a 5-year cycle

SEEDLING DEBARKING WEEVIL

The seedling debarking weevil, *Hylobius congener* D.T., Sch. & Marsh., has been a significant cause of mortality of newly planted coniferous seedlings in central Nova Scotia since the early 1980s. The problem was first reported in 1984, when seedling mortality exceeded 85% in some plantations. The insect is present on site as early as the time of harvest. Debarking of the stems of seedlings occurs from spring through to fall, resulting in progressively increasing seedling mortality. The amount of damage is related to forest management practices, such as "hot planting" (i.e., the reforesting of cutover areas very soon after harvest), site preparation, plantation size, and the proximity of plantations to other harvested areas. The level of concern for this insect is related to increased awareness by forest managers, the recognition of the fact that some unexplained plantation failures in the past may have been the result of weevil damage, and the realization that, in the absence of practical control methods, the future of large scale plantation programs may be jeopardized.

In 1989, the insect continued to damage newly established plantations in Nova Scotia and Prince Edward Island, however, some losses have been reduced by a program of delayed planting of higher hazard sites. This allows the weevil to complete its life cycle and disperse from the site before seedlings are planted. At the same time, delayed planting can result in alternative weevil food sources developing on the site, which reduces the amount of planted-seedling damage done by any remaining weevils. In Prince Edward Island, site preparation before planting may have reduced losses there. No systematic surveys were conducted in Nova Scotia during 1989. In Prince Edward Island, information from a survey designed to measure the effects of various site preparation techniques was collected under contract during late fall. Preliminary analysis of the data indicates that 77% of the 60 plantations surveyed had some level of damage (compared with 61% of 51 plantations in 1988) and that most of the damage was found in central and eastern Prince Edward Island. In 30% of the plantations more than 5% of seedlings were damaged, compared to 4% in 1988. The amount of damage appears to be related to the method of site preparation. Little or no damage occurred on sites where rhome disk or anchor chains were used to disturb the soil surface, while preparation with brush or root rake did not appear to be effective.

SPRUCE BUDMOTHS

Spruce Budmoths on white spruce comprise a group of closely related species: the spruce budmoth, *Zeiraphera canadensis* Mut. and Free., the purplestriped shootworm, *Zeiraphera unfortunana* Powell, and the yellow spruce budworm, Zeiraphera fortunana (Kft.). Generally *Z. canadensis* is the most common and most important of the three but occasionally the species-mix changes in favor of one of the other two. They have been omnipresent forest pests in the Maritimes since at least the late 1930s, when the Forest Insect and Disease Survey started to keep records. Although widespread, insect populations have generally been low, except for the occasional flare-up, usually on open-grown white spruce. An outbreak occurred in New Brunswick in the mid-1960s when spruce in parts of the southwest Miramichi and the Nashwaak River drainage system sustained moderate to severe defoliation, and in Nova Scotia in the mid-1970s when similar levels of defoliation occurred in areas along the Northumberland Strait and the Fundy Coast.

Spruce budmoth, a not-too-important forest insect in mature forests, became a major pest in 1980, when it was discovered to be causing defoliation, shoot distortion, and tree deformation in white spruce plantations over large areas in New Brunswick. Since then, these insects have been widespread in white spruce plantations throughout the Maritimes and have often caused moderate or severe shoot damage.

In 1989, in New Brunswick, more than 13% of white spruce shoots were damaged by budmoths, compared to 10% last year. Damage occurred throughout the Province and was highest at St. Luc, Kent County, where 41% of the shoots were affected (compared to 49% last year) and 33% at Mitchell Settlement, Restigouche County. More than 20% shoot damage was recorded in several areas of Restigouche, Gloucester, Carleton, Kings, and Westmorland counties.

In Nova Scotia, an average of 11% of white spruce shoots were damaged at locations scattered throughout the Province, compared to 12% last year. The most serious damage occurred at South Williamston, Annapolis County, where 68% of the shoots were affected. Other areas with more than 30% shoot damage included Big Hill, Victoria County (44%), Swallow Hill, Cumberland County (41%) and Round Hill, Annapolis County, (37%).

In Prince Edward Island, an average of almost 19% of white spruce shoots were damaged at the 23 locations assessed, compared to 7% last year and 15% in 1987. Shoot damage was highest in Prince County where 53% of the shoots were affected at Foxley River, and 35% at East Bideford. Over 20% damage occurred at several other locations in this county, as well as in Queens and Kings Counties.

Control - In the fifth year of a developmental program towards control of the spruce budmoths, J.D. Irving Ltd., in cooperation with Forestry Canada -

Maritimes Region, treated 1,800 ha of white spruce plantations with two applications of fenitrothion (Sumithion®) in northwestern New Brunswick. The chemical was applied at 105 g/ha in a total mix of 0.42 L/ha per application (a UULV formulation). Treatment was timed to coincide with adult emergence and results confirmed findings of previous years that, when applied at a suitable timing, enough adult moths are killed to impact on egg laying and significantly reduce damage the following year.

SIROCOCCUS SHOOT BLIGHT

Sirococcus shoot blight, caused by the fungus *Sirococcus conigenus* (DC.) P. Cannon & Minter (previously known as *Sirococcus strobilinus* Preuss), has been known in the Maritimes since the early 1970s but has been present for much longer. The fungus infects and kills newly developed shoots. Fruiting bodies are produced on the twigs, needles, and cone scales, from whence spores disperse and cause new infections. Heavy attacks cause branch mortality, which results in crown dieback and tree mortality. In the Maritimes, the disease affects red pine and occasionally spruce and larch, although other species of pine, hemlock, Douglas fir, and true firs can also be affected. Trees of any size, from seedlings to 15 m in height, are damaged or killed. The initial infection in newly established plantations appears to be closely related to the proximity of older red pine stands, as shown by an earlier study, where 48% of young plantations less than 1 km from older red pine were found infected, compared to 8.7% which were more than 1 km away from an infection source. After the initial infection, the severity of the disease increases as the trees become older.

The disease is present in all three provinces but is most widely distributed in red pine plantations in Nova Scotia, west of the Colchester-Pictou and Halifax-Guysborough county lines, and in natural regeneration in the southern half of New Brunswick.

In 1989, the disease intensified in all three provinces. In many areas, the repeated infection has resulted in serious deterioration of red pine stands and plantations, in some to the extent that salvage operations were carried out.

In New Brunswick, Sirococcus shoot blight occurs mostly in the southern part of the Province, although affected plantations are known as far north as a line from southern Victoria to northern Kent Counties. In 1989, the disease was found in a large red pine plantation at Little Forks, Kent County and in a natural stand near MacKenzie Brook, east of Doaktown, Northumberland County, as well as in areas known to be infected. In both cases, scattered wolf trees or overstory trees are infected and these in turn serve as the source of infection for the plantation trees or natural regeneration. Discussions regarding the removal of wolf trees and the possible pruning of infected younger trees at Little Forks, and in another red pine plantation at Big Forks with a similar situation, have been initiated with provincial and industrial agencies. The deterioration of red pine trees in the Headquarters area of Fundy National Park is continuing. Some trees, 10-12 m high, died, some others have only a few tufts of green foliage left near the top of the trees.

In Nova Scotia, infected red pine plantations, in Colchester and Cumberland Counties and over much of the western part of the Province, continued to deteriorate. Damage was especially serious at Debert, Colchester County, Diligent River, and in the Chignecto Game Sanctuary, Cumberland County, the Stanley Management Area, Hants County and the Kedge River Management Area, Queens County. In the eastern half of the Province, the disease is spreading and intensifying in the Perch Lake area of Pictou County, where it reappeared in 1988 after an incomplete effort to control it in 1986. Sirococcus shoot blight was recorded for the first time in 1989 at Eatonville, Cumberland County, where 60% of the trees were infected; Lake George, Kings County; and in a young 20 ha red pine plantation in East Pubnico, Yarmouth County. Infected trees were observed for the first time since 1974 in the Garden of Eden Barrens, Pictou County, where light and moderate shoot damage occurred on 5-10 m high trees.

About 10% of the trees in a white spruce clone bank at Debert, Colchester County, were infected.

Shoot damage on affected trees averaged 52%. Infected red pine trees are present in the surrounding natural forest and the area of the clone bank which sustained the most damage is located closest to this natural forest. Sanitation measures taken after the discovery of the problem included pruning infected shoots, removing heavily damaged trees, and spraying.

The deterioration of pine stands caused by this disease in western Nova Scotia and the spread of the disease to plantations in the eastern half of the Province, where red pine has been a major plantation species in recent years, makes Sirococcus shoot blight one of the major plantation problems in Nova Scotia.

In Prince Edward Island, the disease has been present at scattered locations and has been under observation for some years at Goose River, Kings County, and at Iona and Selkirk Road, Queens County. At Iona, where it was first reported on a few red pine trees in a 1 ha plantation in 1984, the number of infected shoots per tree has increased from "light" to about 60% on some of the fringe trees in 1986. Further intensification was noted in 1988. At Selkirk Road, the disease was observed for the first time in 1986 and about 1-2% of the red pine supported 5-29% damaged shoots on lower crown branches. In 1989, the disease intensified at all three locations as more shoots became infected. Sirococcus shoot blight was identified for the first time in several areas in the eastern half of the Province. Less than 5% of the trees were affected in red pine plantations at Cardigan, Heatherdale, and Brudenell Point, Kings County and at Mt. Buchanan, Queens County. A natural stand of red pine was found infected at Point Pleasant, Kings County and scattered blue spruce trees were infected in a 12-year-old blue spruce hedge at Point Prim, Queens County. Sanitation measures are planned in these areas by the provincial forestry agencies.

Control - Prompted by concern over the fate of red pine plantations, silvicultural control (pruning) experiments were carried out in Nova Scotia during the fall of 1988 under the aegis of Forestry Canada. Assessments in the fall of 1989 showed that the number of infected trees was reduced by an average of 25% (range 15-40%) in the three treated plantations, while in the non-treated control plantation incidence increased marginally.

PINE LEAF ADELGID

Pine leaf adelgid, *Pineus pinifoliae* (Fitch), requires two coniferous hosts for the completion of its complicated life cycle, during which one sexual and several asexual (parthenogenetic) forms develop. The adelgid alternates between red or black spruce and pine (mostly white pine). On spruce, conspicuous galls are formed, which can resemble cones. Even at high population levels little damage is caused to the tree. On white pine, the adelgid attacks new shoots and causes shoot mortality. When shoot damage is serious, the affected trees die. Attacks on white pine characteristically occur in alternating years in the Maritimes although the full effect of infestations may not be apparent until the following spring when dead shoots become conspicuous.

Pine leaf adelgid is present throughout the Maritimes. From 1942 until the mid-1960s, it often occurred at damaging levels, especially in southern New Brunswick and in Shelburne, Lunenburg, and Queens Counties on the south shore of western Nova Scotia. Populations were generally low and damage was minimal from the mid-1960s to the mid-1980s. There was a drastic increase in pine leaf adelgid populations in parts of western Nova Scotia in 1987, especially on white pine. In the early part of the summer, there were some areas where it was difficult to find white pine needles without at least a few adult female adelgids, having just arrived from nearby spruce trees, sitting near the tips of the needles. In 1988, white pine shoot mortality was evident throughout much of Nova Scotia and averaged 21% at the 104 locations assessed. Most of the heavy damage was found in Queens, Shelburne, Lunenburg, Annapolis, and Digby Counties. On red spruce, new gall formation was much reduced from the levels found in 1987.

In 1989, contrary to expectations of lessening infestation levels, the number of infested white pine shoots in Nova Scotia increased to 36% from 21% infested the previous year. The expectation

was based on the fact that there was an almost eight-fold decrease in the number of galls on red spruce, the alternate host for the adelgid, from 1987 to 1988. The highest incidence levels on white pine were recorded in Queens, Lunenburg, Shelburne, Annapolis, and Digby Counties, the same area so affected in 1988. Fall surveys in 1989 indicated that an average of 7% of the infested shoots died, however, more damage is likely to become evident in the spring of 1990. The most serious damage was recorded at Jeremy's Bay in Kejimkujik National Park, Annapolis County, where 40% of the shoots were killed. On red spruce, where infestation is expressed in gall formation, an average of 17% of the shoots were affected at the 45 locations assessed in the spring of 1989, an increase from the 3% level in 1988. It remains to be seen whether the hot, dry weather in the late summer of 1989 affected the survival of the adelgid populations.

Pine leaf adelgid was rare in the other two provinces, having been found at only one location each, at low populations, on red spruce in New Brunswick and on white pine in Prince Edward Island.

BALSAM WOOLLY ADELGID

The balsam woolly adelgid, *Adelges piceae* (Ratz.), previously known as the balsam woolly aphid, was introduced to North America (Nova Scotia) from Europe around 1900, probably on nursery stock. It became established throughout Nova Scotia, Prince Edward Island, and the southern half of New Brunswick, and at scattered locations throughout much of the remainder of the Province.

This insect attacks balsam fir and feeds on the thin-walled living cells under the bark. In feeding, it introduces a salivary substance into the tissue causing an abnormal multiplication of cells. Both twigs and stems are attacked. When twigs are attacked they become thickened and stubby, a condition called "gouting". On the trunk or stem, the sapwood beneath the infested bark becomes brown and brittle. Many trees in a heavily infested stand die within one season. Infestation is indicated by the presence of a white woolly substance, secreted by the adelgid. At high populations, the stems of affected trees may be completely white.

Attacks by the insect have persisted in parts of the Region for many years, with twig attack being the usual expression in coastal areas and stem attack in inland locations. Losses, in terms of tree growth, mortality, and decreased wood quality, have been substantial. Infestations, particularly in inland New Brunswick, have been much reduced since the mid-1960s as a result of low winter temperatures and death of host trees, killed by the spruce budworm. However, chronic twig attack has persisted in parts of Nova Scotia and Prince Edward Island even though stem attacks have been rare.

In New Brunswick, an increase in stem attack has been noted in the last few years at scattered locations, and although populations are generally light, there are indications that the adelgid is again becoming more common.

In 1989, stem-wool and gouty twigs were observed on 8-32% of balsam fir trees at several locations in St. John, Kings, and Queens counties and on Grand Manan Island, Charlotte County. Gouting was common on young balsam fir regeneration at French Village, Kings County.

In Nova Scotia, balsam woolly adelgid populations have been relatively stable. Most of the damage has occurred in the form of twig attack, which was largely restricted to coastal areas. An average of 31% of the trees were found with twig attack in stands examined in 1989. The heaviest damage occurred at Main-a-Dieu, Cape Breton County and at French Lake, Inverness County, where all balsam fir trees were attacked and at Bear Hill, Inverness County, where 80% of the trees had gouty twigs. The only location of stem attack was observed at East Bay, Cape Breton County.

In Prince Edward Island, balsam woolly adelgid affected 36% of the trees near Pleasant Grove, Queens County in 1989.

WHITEMARKED TUSSOCK MOTH

Whitemarked tussock moth, *Orgyia leucostigma* (J.E. Smith), is a defoliator of considerable

economic importance. Larvae feed on a variety of coniferous and deciduous hosts. Outbreaks of this insect are usually short but severe, followed by a number of years of very low populations.

The last outbreak of whitemarked tussock moth in the Maritimes occurred in the early 1970s and collapsed by 1979, due mainly to a nuclear polyhedrosis virus. Populations were very low until 1984, when the first signs of a new build-up were observed. By 1985, the insect, although still at generally low populations, was common in most of mainland Nova Scotia and in southern New Brunswick. In 1986, whitemarked tussock moth was present in many areas in the Region but caused noticeable defoliation only in eastern mainland Nova Scotia. Defoliation was patchy at various levels of intensity, affecting white birch, red maple, apple, larch, and balsam fir. However, diseased larvae were present at a number of locations and, in 1987, populations collapsed before an outbreak developed. Also in 1987, whitemarked tussock moth caused light defoliation in northern Kings County in Prince Edward Island. Populations were low in New Brunswick and no defoliation was observed. In 1988, populations appeared to be increasing in New Brunswick and moderate defoliation occurred in Queens County; only trace defoliation occurred in Nova Scotia, and light defoliation in Kings County, Prince Edward Island.

In 1989, whitemarked tussock moth populations were generally low throughout the Maritimes and little defoliation occurred in a few isolated areas. In New Brunswick, larvae in the summer, then egg masses in the fall, were common on alder and white spruce in the Fredericton area, York County, in numerous orchards in Charlotte County, and around Rexton, Kent County. A few larvae were present on white birch at Allainville, Northumberland County. There was no visible defoliation in the Jemseg area, Queens County, where moderate defoliation of various hardwood species occurred in 1988.

In Nova Scotia, trace and light defoliation of hardwoods and understory balsam fir occurred for the second consecutive year in the New France-Havelock area of Digby County, but there was no appreciable increase in the size of this infestation. Trace defoliation of single trees of various species was observed in Kings, Lunenburg, and Yarmouth Counties, and a few larvae were collected at many locations throughout mainland Nova Scotia. Egg masses were common but not numerous throughout the Province, especially in Digby, Annapolis, Lunenburg, and Queens Counties.

In Prince Edward Island, spotty moderate and light defoliation was observed on speckled alder bushes at Sherbrooke, Prince County and at North Enmore, Prince County.

RUSTS ON NEEDLES, LEAVES, AND CONES

Needles of conifers can be infected by a variety of rust fungi which cause the infected needles to fall off the tree prematurely. When infection levels are high, damage (such as reduced Christmas tree grade) and growth loss occur or, in the case of repeated severe defoliation, young plantation trees may die.

Most of the rust fungi need two different hosts to complete their life cycle. The alternate host is often a herbaceous or woody plant which occurs in close association with the coniferous host, frequently in the same plantation. The various species of rusts on the conifers are very similar in appearance but, because each species needs a different alternate host, proper identification of the fungus is important when control measures are anticipated.

On hardwoods, the situation is similar to that on conifers. Heavy infection causes foliage discoloration and premature leaf fall. Repeated heavy attacks result in twig and branch dieback and may eventually kill the tree. Many of the leaf rusts, such as those found on poplars and willows, are stages of the same species alternating between these hardwoods and various conifers. Control in these situations, where both hosts are of value, becomes complicated. For example, care must be taken in species selection for use in windbreaks around nurseries, seed orchards or ornamental settings.

The various rusts encountered in 1989 are discussed by host tree species below:

Coniferous hosts

Balsam fir - Needle rusts found on balsam fir in 1989 included *Melampsora abieti-capraearum* Tub. (alternate host: willow), *Pucciniastrum epilobii* Otth (alternate host: fireweed), *Pucciniastrum goeppertianum* (Kuehn) Kleb. (alternate host: blueberry), and *Uredinopsis* sp. (alternate hosts: ferns). All were present throughout the Region but infections were generally very low, exceeding 5% of the needles affected in only a few cases. The highest infection was caused by *Uredinopsis* sp. on the Cape Breton Highlands, where 64% of the needles were affected.

Hemlock - *Pucciniastrum vaccinii* (Wint.) Jorst. (alternate hosts: cranberry, blueberry) was found in three areas of Nova Scotia but infection did not exceed 4% at any of these locations.

Spruce - *Chrysomyxa ledi* (dBy.) and *Chrysomyxa ledicola* Lagh. (alternate host for both: Labrador tea) were present but at very low levels on black spruce, white spruce, and red spruce at scattered locations throughout the Region. The highest infection level was recorded near Castaway Brook, Kent County, New Brunswick where infection was moderate on a few scattered black spruce trees in a wet area. Ornamental blue spruce was affected at Cape Pele, Westmorland County, New Brunswick.

The cone rust *Pucciniastrum americanum* (Farl.) Arth. (alternate host: raspberry) which has caused serious damage in the past few years, was found only at Waterville, Kings County, Nova Scotia, where it affected about 5% of the cones on 30% of the trees in a clonal seed orchard. The systemic cone rust *Chrysomyxa pirolata* Wint. was not found in the Maritimes in 1989.

Larch - *Melampsora medusae* Thuem. (alternate host: poplar) was found at one location in each of the three provinces. Infection levels were very low, although at Wapske, Victoria County, N.B., 80% of the trees were infected.

Pine - *Coleosporium asterum* (Diet.) Syd. (alternate host: goldenrod) and *Coleosporium viburni* Arth. (alternate host: *Viburnum* sp., wild raisin, hobblebush, highbush cranberry, etc.) were the two species of needle rusts encountered on pine in 1989. While *C. viburni* appears mostly on jack pine, *C. asterum* affects both jack pine and red pine and the two species may occur together when their respective alternate hosts are present.

C. viburni has been by far the most important needle rust encountered in recent years in New Brunswick. Until 1985, repeated severe infection and the needle drop that follows resulted in young jack pine plantation trees being left with only their current foliage in a number of areas in the southern half of the Province. Infection levels have declined sharply since 1986, although severe infection still occurs in a few plantations. In 1989, the needle rust was observed in a few jack pine plantations in Gloucester and Restigouche Counties in New Brunswick where it caused light or moderate infection of older needles. All trees were affected in a plantation at North Enmore, Prince County, P.E.I. and needle loss was moderate or severe on the one- and two-year-old shoots. The rust was not observed in Nova Scotia in 1989.

C. asterum was found in a few scattered red pine and jack pine plantations in the Maritimes. The highest level of infection on red pine occurred at Little River, Cumberland County, Nova Scotia and on jack pine at St. Luc, Kent County, New Brunswick, but infection levels did not exceed 14% at either location.

Hardwood hosts

Ash - The ash rust *Puccinia sparganioides* Ell. & Barth. (alternate host: cord grass (*Spartina* sp.)) has been one of the most serious foliage problems on ash in many parts of western Nova Scotia for the past decade, causing foliage discoloration, premature leaf fall, dieback, and some tree mortality.

In 1989, the chronic infection continued in many parts of Nova Scotia and severe damage occurred in some areas. As in 1988, trees were most seriously affected in areas of Digby, Yarmouth, Annapolis, Kings, and Hants Counties; however, the average infection level was 53%, compared to

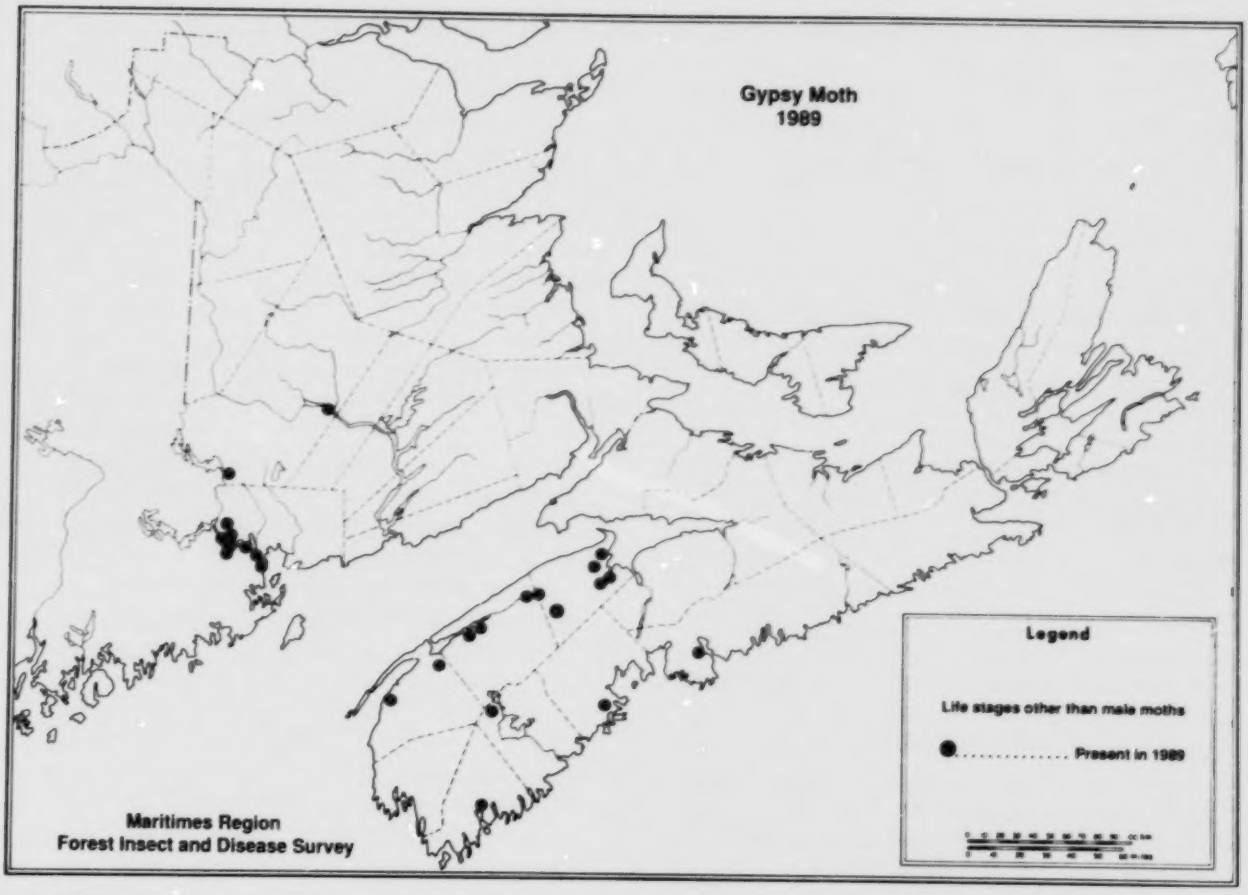


Figure 3.

29% observed last year. The worst infection occurred at Lockhartville, Kings County, where foliage browning of ash was severe or moderate. Moderate browning was again obvious on trees on the west side of Bear River between Smith's Cove and Bear River, Digby County, where the cumulative effects of repeated attack resulted in twig and branch mortality. Tree deterioration was also evident at Gavelton, Yarmouth County, Hantsport, Hants County, and Hortonville, Kings County. Ash rust was not observed in 1989 in either New Brunswick or Prince Edward Island.

Oak - *Cronartium quercuum* (Berk.) Miyabe ex Shirai (alternate host: jack pine), found in 1988 for the first time in the Maritimes on leaves of red oak in a collection from Northumberland County, New Brunswick, was not found anywhere in the Region in 1989.

Trembling aspen - *Melampsora abietis-canadensis* C.A. Ludwig ex Arth. (alternate host: hemlock) caused light infection of trembling aspen trees in one area in Kings County, Prince Edward Island.

GYPSY MOTH

After its reappearance in the Maritimes in 1981, the gypsy moth, *Lymantria dispar* (L.), gained further ground in 1989. The gypsy moth appears to be established in both New Brunswick and Nova Scotia and caused visible defoliation in the Region for the first time in nearly half a century in 1987.

Gypsy moth has been the most destructive insect of hardwoods and, to a lesser degree, of conifers in the northeastern United States for decades. The area affected by defoliation has declined in recent years. However, there was a resurgence of

Table 3. Summary of the results of detection surveys for gypsy moth in New Brunswick 1981 - 1989

County	Location	UTM Grid[1]	Gypsy moth life stages found[2]								
			1981	1982	1983	1984	1985	1986	1987	1988	1989
Carleton	Peel	19-61-513					■	❐	❐	❐	❐
Charlotte	Mohannes	19-62-500	■	■	■	■	■	■	■	■	■
	Beaver Harbour	19-67-499	■	❐	■	❐	❐	❐	❐	❐	❐
	Pennfield	19-68-499	❐	❐	❐	❐	❐	❐	❐	❐	
	Grand Manan Island	19-67-494	■	❐	❐	❐	❐	❐	❐	❐	
	Oak Hill	19-63-502		■	■	■	■	■	■	■	■
	Lynnfield	19-63-502		■	❐	❐	❐	■	❐	❐	
	Didgequash	19-66-500		■	❐	❐	❐	❐	■	❐	■
	St. George	19-67-499		■	■	■	❐	❐	❐	❐	❐
	Campobello Island	19-66-497		■	❐	❐	❐	❐	❐	❐	
	N.W. of Oak Hill	19-62-502			■	■	❐	❐	■	❐	❐
	Upper Mills	19-63-499			■	❐	❐	❐	❐	❐	❐
	Oak Bay area	19-64-501			■	❐	❐	❐	❐	❐	❐
	St. Stephen	19-63-500			■	■	■	❐	❐	■	■
	St. Andrews	19-65-499			■	■	■	■	■	■	■
	Burnt Hill	19-63-500				■	❐	❐	❐	❐	❐
	Old Ridge	19-63-500					■	❐	❐	■	■
	Bayside	19-64-500					■	❐	❐	❐	
	Little Ridge	19-62-500					■	■	❐	❐	❐
	Grand Falls Dam	19-61-501					■	❐	❐	❐	❐
	Basswood Ridge	19-62-501					■	❐	❐	❐	❐
	Moores Mills	19-63-501						■	■	■	■
	Pleasant Ridge NW	19-65-503						■	❐	❐	❐
	Anderson Settlement	19-63-503						■	❐	❐	❐
	Gaillie Settlement	19-63-502						■	❐	❐	❐
	W Moores Mills Lake	19-63-501							■	❐	❐
	S of Cranberry Lake	19-63-501							■	❐	❐
	Heathland	19-63-500							■	❐	❐
	SE of Scotch Ridge	19-62-501							■	❐	❐
	Mayfield	19-63-500							■	❐	
	Ledge Road	19-64-500							■	❐	■
	S of Beaconfield	19-62-503							■	❐	❐
	N of Oak Hill	19-62-502							■	❐	❐
	NE of Scotch Ridge	19-62-501							■	❐	
	S Maxwell Crossing	19-63-500							■	❐	❐
	Rollingdam	19-65-501							■	❐	❐
	Oak Bay Prov. Park	19-64-500							■	❐	❐
	Scotch Ridge	19-62-501								■	■
	Greenrock	19-64-501								■	❐
	Indian Pond	19-63-502								■	❐
	Milltown	19-63-500									■
St. John	Saint John	19-72-501		■	❐	❐	❐	❐	❐	❐	
York	Fredericton	19-68-509			■	■	■	■	❐	❐	■
	Forest City	19-59-505					■	❐	❐	■	
	St. Croix	19-62-504					■	❐	❐	❐	❐
	McAdam	19-63-505						■	❐	❐	■
	Woukichegan Lake	19-62-505						■	❐	❐	
	Beaverdam	19-67-507							■	❐	

[1] U.T.M. = Universal Transverse Mercator System.

[2] Life stages other than adults: ■ = Gypsy moth found; ❐ = Gypsy moth not found.

gypsy moth populations in 1989 and the area of defoliation increased sharply. The status of the outbreak in Maine has been of special concern to us because of its proximity to our Region. After a low of only 40 ha of gypsy moth defoliation in Maine in 1988, the area of defoliation increased to 13,850 ha in 1989.

In the Maritimes, the Gypsy Moth Monitoring Committee remained active in 1989, and again coordinated all surveys and monitored the control activities as laid out in two federal-provincial agreements with the provinces of New Brunswick and Nova Scotia. Agriculture Canada administered the agreements on behalf of the federal government. The committee was formed in response to the discovery of gypsy moth in 1981, in an effort to make more efficient use of available manpower to combat this threat to the Region's forests. Organizations involved in surveys include Forestry Canada; Parks Canada of Environment Canada; the Plant Health and Inspection Branch of Agriculture Canada; New Brunswick Department of Natural Resources; New Brunswick Department of Agriculture; New Brunswick Department of Tourism, Recreation and Heritage; Nova Scotia Department of Lands and Forests; Nova Scotia Department of Agriculture; Prince Edward Island Department of Energy and Forestry; and numerous municipalities. Many volunteers, campground operators, small woodlot owners, Christmas tree growers, students, and other interested private citizens also assisted in the pheromone trapping program.

In 1989, early season egg mass surveys, larval surveys, late-fall egg mass surveys, and adult trapping programs were conducted to determine the current status of the insect in the Region and to effect control in designated areas.

The adult-male trapping programs are aimed at defining areas where egg mass searches should be concentrated. Traps are also placed in higher densities in infested areas with the aim of capturing males to reduce mating frequency and consequently the number of fertile egg masses. As a result of studies since 1980, the trap placement design was changed in 1983 to eliminate, or at least to minimize, interference from large numbers of male moths brought into the Region by weather fronts from infested areas in the United States. "Survey" traps are now placed in late July. The date was not changed for trap placement for control purposes and those traps are still placed at the beginning of July. Information was obtained from 7,263 traps in the Region, 2,945 in New Brunswick, 3,979 in Nova Scotia, and 339 in Prince Edward Island, representing a 95% trap return. The high return, because of better understanding by cooperators of the value of negative results, greatly aided the planning of the fall egg mass surveys.

The status of the gypsy moth in the Maritimes in 1989 was as follows:

In New Brunswick, gypsy moth larvae, egg masses and/or pupae were found during egg mass surveys at 11 locations (Fig. 3 and Table 3) The total number of areas where gypsy moth has been found at least once since 1981 is 48. However, only eight of these areas are outside Charlotte County and, with the exception of Fredericton, McAdam, and Forest City, the gypsy moth has been found only once at any of these locations. In Saint John, an unemerged pupa was found in 1981 and the lack of any activity in this area since then suggests that this was a larval introduction rather than an egg mass. A similar situation is suspected in the area near Peel, Carleton County, where two years of extensive trapping and searching have failed to confirm the presence of gypsy moth.

Over 80% of the known gypsy moth locations in New Brunswick are in Charlotte County and all but one of the 11 areas where gypsy moth was found in 1989 are in the western half of the county or in areas adjacent to it in southwestern York County. In view of this, the western half of Charlotte County of New Brunswick is considered to sustain a generally low level but widespread population of gypsy moth, both in forest and, at least in the case of St. Andrews and St. Stephen, in urban settings. However, the nine positive locations in 1989 represent only 3% of the 300 areas searched for egg masses in Charlotte and southwestern York counties, and thus indicate low gypsy moth populations.

Table 4. Summary of the results of detection surveys for gypsy moth in Nova Scotia 1981 - 1989

County	Location	UTM Grid[1]	Gypsy moth life stages found[2]								
			1981	1982	1983	1984	1985	1986	1987	1988	1989
Yarmouth	Yarmouth	20-24-485	■	■	■	❐	■	❐	❐	❐	
	Tusket	20-26-486			■	■	■	❐	❐	❐	
Digby	Grosses Coques	20-25-491		■	■	❐	❐	❐	❐	❐	
	Smiths Cove	20-28-494		■	❐	❐	❐	❐	❐	❐	
	Digby	20-28-494			■	❐	❐	❐	❐	❐	❐
	Weymouth	20-26-492				■	■	■	■	■	■
	Weymouth Falls & Tusket Road	20-26-492				■	■	❐	❐	❐	
	Bear River	20-28-493					■	❐	❐	❐	■
Annapolis	Clementsport	20-29-494		■	❐	■	■	❐	❐	❐	
	Paradise	20-32-497		■	■	❐	❐	❐	❐	❐	
	Kejimkujik Nat. Pk	20-31-492			■	❐	❐	❐	❐	❐	
	Middleton	20-33-497				■	■	❐	❐	❐	■
	Annapolis Royal	20-30-495					■	■	■	■	■
	CFB Cornwallis	20-29-494						■	❐	❐	
	Bridgetown	20-31-496							■	■	
Queens	Kejimkujik Nat. Pk	20-32-491						■	■	■	■
Kings	New Minas	20-38-499			■	■	■	■	■	■	■
	Port Williams	20-38-499					■	■	■	■	■
	CFB Greenwood	20-34-498						■	■	■	■
	Canning	20-38-500							■	■	■
	Kentville	20-38-499							■	■	■
	Lake Paul	20-36-496									■
Halifax	Halifax	20-45-494			■	■	■	■	■	■	■
	Dartmouth	20-45-494				■	■	❐	❐	■	❐
Shelburne	Shelburne	20-31-484			■	■	■	■	■	■	■
	CFB Shelburne	20-31-484						■	■	❐	
	Clyde River	20-30-483			■	❐	❐	❐	❐	❐	
Lunenburg	Bridgewater	20-37-491					■	■	■	■	■
Hants	Windsor	20-41-498					■	■	❐	❐	❐

[1] U.T.M. Grid = Universal Transverse Mercator System.
[2] Life stages other than adults: ■ = Gypsy moth found; ❐ = Gypsy moth not found.

In Nova Scotia, gypsy moth was found at 15 locations (Fig. 3 and Table 4), all in the western half of the Province. All but one of the areas were either the same or adjacent to areas where the insect had been found in previous years. The exception was a location near Lake Paul, Kings County, where a single early instar larva was found on a maple tree. Egg masses were not numerous in most areas but, even in areas where egg mass counts were relatively higher, little noticeable defoliation occurred in 1989. It is worth noting that gypsy moth was not found in several areas where egg masses were present in previous years and that, with the exception of Lake Paul, all positive locations are the same as in 1988.

Table 5. Summary of trapout and delimitation trapping programs for gypsy moth in New Brunswick in 1989

Location	Number of Traps			Moths Caught			Egg mass
	Placed	Ret'd	Posit.	Total	Per trap	Range	
Mohannes	56	56	56	1426	25.5	15-41	Yes
Cedar Mills (Scotch Ridge)	50	49	49	934	19.1	4-32	Yes
Old Ridge	50	50	50	767	15.3	1-32	Yes
Oak Hill	50	50	49	510	10.2	0-25	Yes
St. Stephen	571	556	548	5033	9.1	0-24	Yes
Doufor-Cedar Mill area	100	96	87	528	5.5	0-21	---
Moores Mills	199	196	175	990	5.1	0-23	Yes
Charlotte County "leading edge"	201	171	162	885	5.0	0-22	---
Old Ridge (McKinney Place)	10	10	9	46	4.6	0-10	---
St. Andrews	549	532	474	2099	3.9	0-19	Yes
St. George	50	47	34	140	3.0	0-12	---
Forest City	75	75	52	196	2.6	0-19	---
CFB Gagetown/Oromocto	50	43	33	98	2.3	0-10	---
Fredericton	611	591	226	404	0.7	0-19	Yes
Moncton	10	8	4	5	0.6	0-2	---
Fundy National Park	25	25	9	14	0.6	9-2	---
Sussex	16	16	7	8	0.5	0-2	---
Saint John	10	9	1	1	0.1	0-1	---
Kouchibouguac National Park	16	5	0	0	0	0	---
CFB Chatham	10	9	0	0	0	0	---

In Prince Edward Island, the gypsy moth is not known to occur to date. There were only 21 male moths caught in the 339 pheromone traps in the Province. Most were single catches, no more than three males were captured in any of the traps, and no egg masses were found at any of these locations.

The results of gypsy moth surveys, other than adult trapping programs, conducted from 1981 to 1989 are summarized in Tables 3 and 4. In New Brunswick, most of the gypsy moth locations are in forested areas, away from habitation, and are concentrated in a small section of the Province adjacent to an area of the United States where the insect is known to be present. In Nova Scotia, almost all of the infested spots are inhabited areas with considerable movement of people. This suggests that, while in New Brunswick the presence of gypsy moth, in most places, may be the result of natural spread, in Nova Scotia the insect was likely imported by commercial traffic, visitors or residents travelling in gypsy moth-infested areas.

Control operations against the gypsy moth in 1989 were conducted at a number of clearly defined locations in accordance with federal-provincial agreements with the provinces of New Brunswick and Nova Scotia as stated above. At most locations, controls in 1989 consisted of trapout or "heavy" trapping programs to lower male moth populations in advance of mating and to better define areas of infestations in advance of the 1990 programs. The results of these trapping programs are summarized in Table 5 for New Brunswick, Table 6 for Nova Scotia, and Table 7 for Prince Edward Island. Some of this information is repeated for those locations where control efforts have been under way previous to 1989, to provide a complete record of those efforts. Moth catches in areas of repeated trapping were generally much higher than in previous years,

Table 6. Summary of trapout and delimitation trapping program for gypsy moth in Nova Scotia in 1989.

Location	Number of Traps			Moths Caught			Egg
	Placed	Ret'd	Posit.	Total	Per trap	Range	mass
Kejimkujik Nat. Park	256	252	234	2621	10.4	0-32	Yes
Canning	98	93	85	1009	10.3	0-33	Yes
New Minas	584	566	459	4440	7.6	0-38	Yes
Annapolis Royal	475	414	287	2314	5.6	0-28	Yes
Bridgetown	96	83	61	402	4.8	0-23	Yes
Halifax	289	236	87	435	1.8	0-22	Yes
Dartmouth	53	42	15	66	1.6	0-19	---
Bridgewater	149	142	57	232	1.6	0-18	Yes
Wolfville	50	45	25	64	1.3	0-9	---
Shelburne	465	439	184	503	1.2	0-18	Yes
Digby	50	50	18	44	0.9	0-17	---
Port Williams	100	98	31	79	0.8	0-16	Yes
Middleton	24	24	8	17	0.7	0-8	Yes
CFB Greenwood	50	41	16	28	0.7	0-5	Yes
Kentville	448	420	88	150	0.3	0-12	Yes
Yarmouth	50	49	11	12	0.2	2-2	---
Weymouth	100	94	10	16	0.2	0-4	Yes
Eastern mainland	214	201	27	37	0.1	0-6	---
Cape Breton Island	99	99	4	4	<0.1	0-1	---
Cape Breton Highlands National Park	13	11	1	1	<0.1	0-1	---
Paradise	21	21	0	0	0	0	---

possibly indicating an intensification of infestations. However, gypsy moth outbreaks in the United States were more extensive than during the past few years, weather patterns in 1989 were markedly different from those in 1987 and 1988, and the limited number of daily observation traps indicate that at least some of the gypsy moth males captured in the Maritimes in 1989 were blown-in and originated in areas remote from the capture points. The lead agency listed below for the various programs carried the major responsibility, with assistance at various levels from other cooperating agencies. All pheromone traps were provided by Agriculture Canada.

Table 7. Summary of trapout and delimitation trapping programs for gypsy moth in Prince Edward Island in 1989.

Location	Number of Traps			Moths Caught			Egg
	Placed	Ret'd	Posit.	Caught	Per trap	Range	mass
Prince Edward Island - general	325	316	16	21	<0.1	0-3	---
P.E.I. National Park	25	23	0	0	0	0	---

Moores Mills, N.B. - In 1987, at the site of the first high intensity outbreak in the Maritimes in half a century, a cooperative effort to eradicate, or at least reduce, the population included cutting, then root-raking all vegetation on a 4-ha area, followed by an intensive trapout program, ground spraying, an egg mass search-and-destroy operation, and burning of the piled-up brush. This effort was followed in 1988 with: spring egg mass surveys; ground spraying with permethrin (Ambush 500 ECR®) at a rate of 35g/ha; aerial spraying of a 130 ha area, centering around the 1987 hot spot, with *B.t.* (Futura®, 30 BIU/ha, 3 applications); a trap-out program; and fall egg mass surveys. The larval population, following the *B.t.* spray, was reduced from a pre-spray value of 3.8 larvae/hour-search to a post-spray 0.2 larvae/hour-search. The adult male catch in the trap-out program in 1987 was 3,322 males caught in 347 traps (9.6 moths/trap). In 1988, this was reduced to 32 moths caught in 305 traps, a mere 0.1 moth/trap. A few (2) fresh egg masses were found in the fall, indicating that, even though the population was drastically reduced, total eradication has not yet been achieved. In 1989, 990 moths were caught in the 196 traps assessed (5.1 moths/trap) and a single fresh egg mass was found during the fall search. Lead agency: New Brunswick Department of Natural Resources.

Mohannes, N.B - A 257 ha area, at the site of the first gypsy moth find in 1981, received three aerial applications of *B.t.* (Futura®; 30 BIU/ha) in 1988. In this area, in 1983, 18 ha were clearcut of oak, 102 ha were sprayed with *B.t.* and over 5,000 egg parasites (*Anastatus disparis*) were released. Extensive annual egg mass surveys since then served the dual purpose of removing egg masses and obtaining rearing material for parasite recovery rearing. The parasite has never been recovered from this or from neighbouring areas of Maine (thanks to the Maine Forest Service for their cooperation in this project). In the fall of 1988, one fresh egg mass was found in the Mohannes area. The 0.01 egg mass/hour search-ratio indicated very low populations. In 1989, the situation was reversed. Trapping captured 1,426 male moths in the 56 traps assessed. The average of 25.5 moths/trap was by far the highest anywhere in the Maritimes and as many as 41 moths were caught in one of the traps. There were 76 egg masses discovered during fall surveys, almost all in an area southeast of the 1988 spray block. Lead agency: New Brunswick Department of Natural Resources.

Fredericton, N.B. - A trapout program in a small area of the city where over two dozen egg masses were found in 1983, was repeated for a fourth year. Trap intensity in 1989 was reduced from previous years. The following information indicates that gypsy moth, if not eliminated, was reduced to sub-detectable levels in the trapout area. (In 1985, the year before the program started, 15 egg masses were found.) However, two egg masses were found in 1989 adjacent to the border of the trapout area (on the opposite side of the street).

1986 - 650 traps; 231 male moths;	4 egg masses
1987 - 572 traps; 9 male moths;	0 egg masses
1988 - 556 traps; 5 male moths	0 egg masses
1989 - 290 traps; 146 male moths	0 egg masses (see above)

The discovery of 16 egg masses in another part of Fredericton in the fall of 1989 was followed by an intensive search and destroy program combined with a media blitz to alert residents and engage their cooperation. Lead agency: City of Fredericton, with advice from Forestry Canada - Maritimes Region. Assistance in egg mass searches is provided by the Maritimes Forest Ranger School class each year.

St. Andrews, N.B. - After a few years of "heavy surveying", a trapout program was initiated in 1988 in the part of the town where egg masses were regularly found. Of the 595 traps placed, 564 were returned. A total of 478 moths were captured in the 235 positive traps (0.8 moths/trap). Egg masses (26) were found in the fall and more egg masses (15) were found in the spring when further searches were conducted with the assistance of local schools. In 1989, 474 of the 532 traps assessed were positive and 2,099 moths were captured (3.9 moths/trap). Preliminary surveys in the fall located 20 egg masses and there is little doubt that more will be found and destroyed during additional searches. Lead agency: Agriculture Canada, with cooperation from the town.

St. Stephen, N.B. - The trapout program in 1988 involved the placement of 430 traps, of which 359 were returned. Sixty traps were negative but 1,315 moths were caught in the 299 positive traps (3.7 moths/trap). Egg masses (16) were found in the fall and more egg masses (94) were found in the spring when further searches were conducted with the assistance of local schools. In 1989, 548 of the 556 traps assessed were positive and 5,033 moths were captured (9.1 moths/trap). Preliminary surveys in the fall located 48 egg masses and there is little doubt that more will be found and destroyed during additional searches. Lead agency: Agriculture Canada with cooperation from the town.

Yarmouth, N.S. - After the discovery of gypsy moth in the town in 1981, the Nova Scotia Department of Lands and Forests conducted a vigorous control program involving heavy trapping, spraying of trees with the bacterial agent *B.t.*, and implanting systemic insecticides into selected trees, with the cooperation of town officials and citizens. The number of egg masses destroyed in any given year was never high, these numbers declined each year and no egg masses have been found in the town since 1986. Trapping programs have been in effect annually but very few moths have been captured. In 1989, 11 of the 49 traps assessed were positive but only 12 moths were captured (0.2 moths/trap). No egg masses were found. Lead agency: Nova Scotia Department of Lands and Forests.

Shelburne, N.S. - Trapout programs have been conducted in the town annually since 1986. About 500 moths were caught in 388 traps in 1987 (approx. 1.3 moths/trap) and 319 moths captured in 400 traps in 1988 (ave. 0.8 moths/trap). Egg masses were found in the town each fall. In 1989, 184 of the 439 traps assessed were positive and 503 moths were captured (l.2 moths/trap). Preliminary surveys in the fall located 22 egg masses and there is little doubt that more will be found and destroyed during additional searches. Lead agency: Nova Scotia Department of Lands and Forests.

Annapolis Royal, N.S. - The trapout program in 1988 involved 284 traps and 1,648 moths were captured (5.8 moths/trap). Egg masses were found in the fall. The program in 1988 was conducted by the Nova Scotia Department of Lands and Forests. In 1989, during spring searches, conducted with the cooperation of the local high school, 165 egg masses were found and destroyed. The trapping program involved 414 traps, of which 287 were positive, and 2,314 moths were captured (5.6 moths/trap). Preliminary surveys in the fall located 13 egg masses and there is little doubt that more will be found and destroyed during additional searches. It may be worthy of note that, of all areas with repeated trapping programs, Annapolis Royal is the only location where there was a decrease in the average moths/trap figure in 1989. Lead agency: Agriculture Canada.

New Minas, N.S. - Although trapping programs have been conducted in the past, results in previous years have been combined with those from Kentville. In 1988, the combined New Minas-Kentville program involved the assessment of 1,178 traps, of which 346 were positive, and 2,430 moths were captured (2.1 moths/trap). The majority of the positive traps and of the moths captured were in New Minas. In 1989, there were 566 traps assessed from New Minas, of which 459 were positive, and 4,440 moths were captured (7.6 moths/trap). Large numbers of early instar larvae were found in an apple orchard in the early summer and the orchard was sprayed to control the infestation. Although noticeable defoliation occurred on the apple trees, most of this was attributed to defoliation by winter moth (*Operophtera brumata*), as gypsy moth larvae were too young and too few to have caused the damage observed. Females were observed laying eggs on August 20 and a few other egg masses were found during preliminary surveys but there is little doubt that a gypsy moth population exists in New Minas. Lead agency: Nova Scotia Department of Lands and Forests.

Kentville, N.S. - Although trapping programs have been conducted in the past, results in previous years have been combined with those from New Minas. In 1988, the combined New Minas-Kentville program involved the assessment of 1,178 traps, of which 346 were positive, and 2,430 moths were captured (2.1 moths/trap). The

majority of the positive traps and of the moths captured were in New Minas. In 1989, there were 420 traps assessed from Kentville, of which 88 were positive, and 150 moths were captured (0.3 moths/trap) Only one egg mass was found during preliminary surveys. Lead agency: Nova Scotia Department of Lands and Forests.

Canning, N.S. - Although trapping programs have been conducted in the past, results in previous years have been combined with those from Port Williams. In 1988, the combined Port Williams-Canning program involved the assessment of 188 traps, of which 84 were positive, and 734 moths were captured (3.9 moths/trap). In 1989, there were 93 traps assessed, of which 85 were positive, and 1009 moths were captured (10.3 moths/trap). Preliminary surveys in the fall located nine egg masses, numerous pupal cases and larval remains and there is little doubt that more will be found during additional searches. Lead agency: Nova Scotia Department of Lands and Forests.

Port Williams, N.S. - Although trapping programs have been conducted in the past, results in previous years have been combined with those from Canning. In 1988, the combined Port Williams-Canning program involved the assessment of 188 traps, of which 84 were positive, and 734 moths were captured (3.9 moths/trap). In 1989, there were 98 traps assessed, of which 31 were positive, and 79 moths were captured (0.8 moths/trap). Preliminary surveys in the fall located two egg masses, a pupal case, and a cast larval skin. Further searches are necessary to obtain a clearer understanding of the magnitude of the infestation. Lead agency: Nova Scotia Department of Lands and Forests.

Bridgewater, N.S. - The trapout program in 1988 involved 192 traps assessed, of which 51 were positive, and 129 moths were captured (0.7 moths/trap). A few egg masses were found in the fall. In 1989, there were 142 traps assessed, of which 57 were positive, and 232 moths were captured (1.6 moths/trap). Preliminary surveys in the fall located three egg masses. Lead agency: Nova Scotia Department of Lands and Forests.

Kejimkujik National Park, N.S. - Delimitation surveys have been conducted since 1984 after the discovery of the first egg mass in the Park in 1983. In 1988, the program involved 112 traps, of which 111 were positive, and 689 moths were captured (6.2 moths/trap). Surveys in the fall and spring of 1989, with the cooperation of a class of students from the North Queens Rural High School, resulted in the discovery of only a few egg masses. In 1989, 252 traps were assessed from the Park and adjacent areas, of which 234 were positive, and 2,621 moths were captured. The average moth catch of 10.4 moths/trap was the highest among all concentrated trapping programs in Nova Scotia. Also in 1989, burlap traps were placed on five trees at locations of high moth catches or where egg masses were found in 1988. Of the locations trapped, gypsy moths were found at only one of the 10 sites, where all five traps contained egg masses, larval skins or pupal cases. This point of infestation is located about 1.5 km southwest of the Mersey River, between George Lake and Loon Lake. In addition, single egg masses were found at three other locations in the Park, within 6 km of the group of "positive" burlap traps. Lead agency: Forestry Canada with cooperation from Parks Canada personnel.

OAK LEAFROLLER AND OAK LEAF SHREDDER

Oak Leafroller, *Pseudexentera spoliana* (Clem.), and the Oak Leaf Shredder, *Croesia semipurpurana* (Kft.), have been defoliating oak since the early 1970s and are the most serious pests of oak in the Maritimes. As a result of repeated defoliation, oak trees in many areas are suffering from various degrees of twig, branch, and crown dieback. Insect populations started declining in 1983 and the decline continued in 1984, but the insects still caused various amounts of defoliation of oak in 1985 throughout the Region. By 1986, only spot infestations remained in New Brunswick and Prince Edward Island but widespread defoliation occurred in western Nova Scotia. The situation remained the same in 1987 and 1988.

In 1989, the insects, predominantly the oak leafroller, were present again in western Nova Scotia but both the area and the intensity of

Table 8. Tree condition of red oak after repeated defoliation in western Nova Scotia, 1988 and 1989

Tree Condition Classes	Percent of trees in class	
	1988(a)	1989(b)
Healthy	9.1	1.0
Twig dieback only	22.6	18.2
Branch dieback 1-25%	42.9	52.2
26-50%	14.3	18.9
51- %	5.0	4.9
dying	0.6	0.9
Dead	5.5	3.9

(a) based on assessment of 931 trees
(b) based on assessment of 1004 trees

defoliation were much reduced from last year. Defoliation of red oak affected 8,200 ha, a 64% reduction from the 22,800 ha recorded in 1988, and occurred mainly in scattered stands in Annapolis, Lunenburg, Queens, and Shelburne Counties. The intensity of defoliation, which ranged from 0% to 93% in the areas assessed, averaged 35%, only half of the average intensity of 69% observed in 1988. Another survey, in conjunction with tree condition assessments, also showed that defoliation was reduced. The average defoliation of red oak at permanent observation plots, in Queens and Lunenburg Counties, was 23% (range 11 to 32%), a 31% reduction from last year's level of 54%. The most severe defoliation was once again observed in Kejimkujik National Park where 93% of the leaves were affected near McGinty Bog, Queens County.

As a result of repeated serious defoliation, red oak stands in western Nova Scotia are in a generally deteriorating condition. A survey of tree condition in 35 stands in 1988 found that at least some crown dieback is present in all red oak stands in Queens, Annapolis, and Lunenburg Counties and that at least some stands are affected in the other counties in this part of the Province. In 1989, the survey was repeated and the condition of red oak assessed in 40 stands. The results for the two years (Table 8) show that not only is red oak unhealthy but also the deterioration is progressive, in spite of the fact that insect populations and current defoliation were both reduced from the previous year. This worsening of the general tree condition is likely to continue unless defoliation by these two insects wanes.

In addition to the serious damage these insects are causing in western Nova Scotia, an indirect problem could be the delay in the early detection of infestations by gypsy moth, a recently introduced insect in this part of the Province, for which oak is one of the most favored host species.

In New Brunswick, severe defoliation was observed only at Cranberry Lake, Queens County, in the area with the longest history of continuous infestation. Defoliation levels were around 90% and all red oak trees were affected in the area. Both species were captured in pheromone traps, however, oak leaf shredder numbers increased five-fold from 1988; this insect has traditionally outnumbered oak leafroller in this area.

In Prince Edward Island, oak leafroller damaged all newly emerging foliage at Milton, Queens County, resulting in severe or moderate defoliation of red oak. Moderate damage was also observed on scattered trees near Afton Road, Queens County. A combination of oak leafroller and oak leaf shredder caused light defoliation in Charlottetown and Milton, Queens County and at Brudenell Point, Kings County.

Pseudexentera spoliana (Clem.), the oak olethreutid leafroller, is the officially recognized name of the insect found in the Maritimes, but was

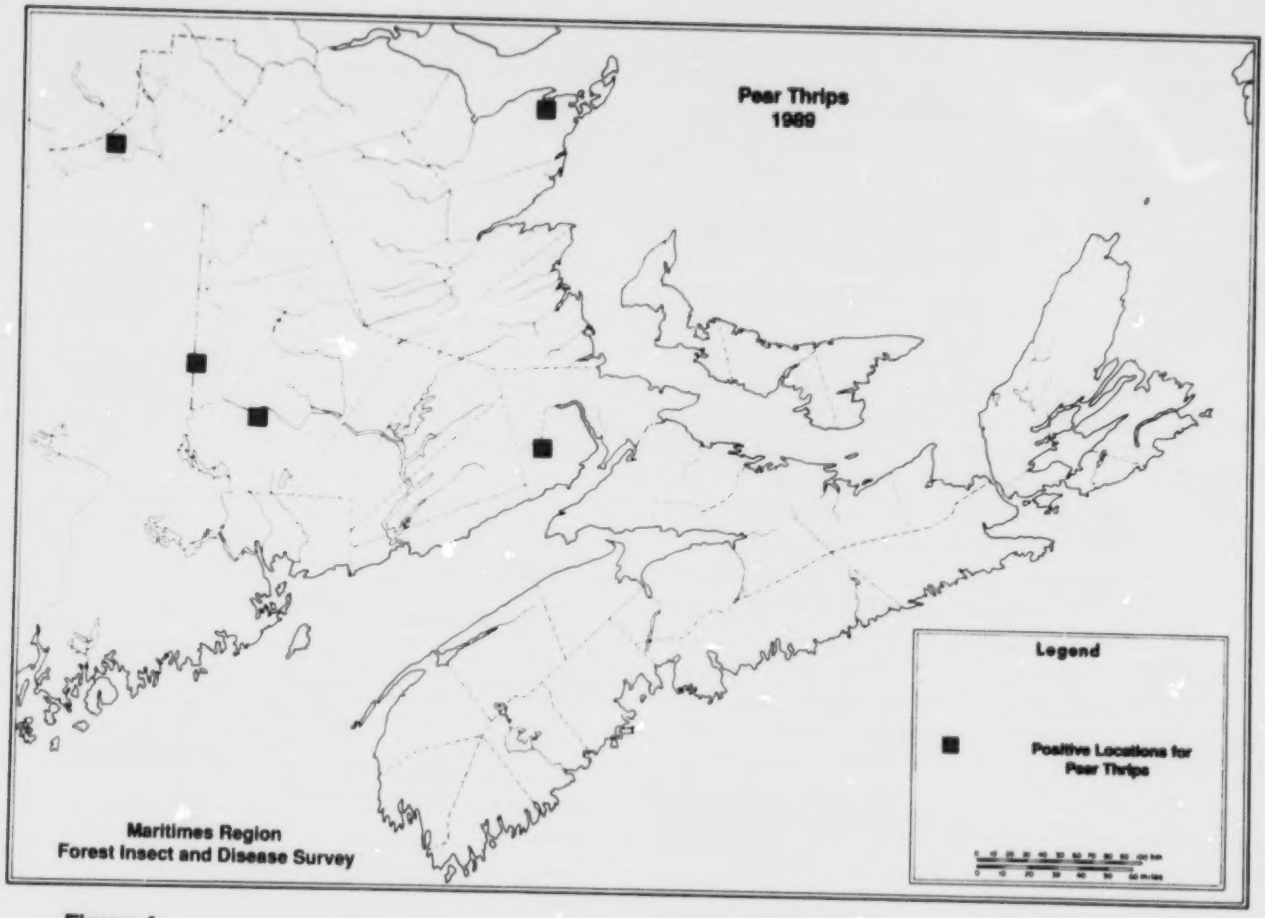


Figure 4.

referred to as *Pseudexentera cressoniana* (Clem.) in past FIDS reports. The need for correction surfaced in connection with work on pheromones. For the sake of brevity, we will refer to *P. spoliana* as the oak leafroller. Our past records of *P. cressoniana* should be interpreted as *P. spoliana*.

OTHER HARDWOOD DEFOLIATORS

Many insects of hardwoods are active in the forest each year. The majority are either of little consequence or of only local concern. These are listed in the chapter "Other Insects and Diseases" in this report. The few hardwood insects of major importance are discussed in separate chapters. Still others are usually discussed here in some detail to bring them to the attention of the reader.

During the past four seasons most hardwood defoliators were of only localized concern or were found at low populations, causing negligible defoliation. The statement made previously that these insects were noted more for their lack of damage than for having caused significant defoliation over large areas applies again in 1989. Consequently, no "other" hardwood defoliators are included in this chapter this year, even though some, such as the spearmarked black moth, appear to be on the increase.

PEAR THRIPS

Pear thrips, *Taeniothrips inconsequens* (Uzel), a diminutive sucking insect, hardly visible to the naked eye, caused major concern in the early summer of 1988 when widespread severe and moderate defoliation of sugar maple occurred in

much of New England, especially Pennsylvania, and New York, as a result of extremely high populations. Close to 200,000 ha of defoliation were recorded in Vermont alone and damage was observed as far east as western Maine. Known mainly as a pest of fruit trees since its introduction to California around the turn of the century, pear thrips was first recognized as a forest pest in 1979 when it caused widespread defoliation in Pennsylvania.

In 1989, early surveys in the Maritimes failed to detect the insect. Acting on a "clue" from the Maine Forest Service that tiny larvae appear as "dandruff" on the underside of leaves of sugar maple, often under severe stress, the insect was found on seven sugar maple trees in five widely separated areas in York, Carleton, Madawaska, Gloucester, and Albert Counties in New Brunswick (Fig. 4). Further surveys will be necessary before a reliable statement can be made regarding the distribution of pear thrips in the Maritimes. However, the insect is present and, even though some host trees on which it was found in 1989 were stressed by other factors, its potential to cause damage has been demonstrated elsewhere.

CASEBEARERS, LEAFMINERS, AND SKELETONIZERS

Some insects with specialized feeding habits, which do not consume leaves and needles in a manner typical of most defoliators, are discussed in this chapter.

Casebearers spend their lives hidden in cigar-shaped cases built of leaf or needle material, attached to the leaf surface. They reach out to feed only as far as the protection of the case allows. When the edible portion of the leaf is consumed, the insect moves, "house and all", to a new feeding location. Consequently, feeding by casebearers initially appears patchy but, later in the season, if populations are high, the patches merge and the foliage becomes generally discolored.

Leafminers live hidden between the upper and lower protective layers of the leaf and feed on the green inner portion. In the process, the leaf becomes discolored. The extent of discoloration depends on the amount of green tissue consumed. Some species consume much of the leaf, others cut off water supply to portions of the leaf, which then turns brown. Still others travel in a characteristic fashion within the leaf, in a pattern typical of the insect species.

Skeletonizers feed on the surface of leaves, usually on the underside, leaving the veins and the upper surface intact. Damaged tissue turns brown due to exposure to air and to lack of water reaching it and the leaves appear scorched. Heavily skeletonized leaves dry up and fall prematurely, thus feeding by these insects results in defoliation.

On Birch

Birch Casebearer, *Coleophora serratella* (L.), an introduced insect, first reported from Maine in 1927, is now widespread throughout the Maritimes. Its preferred host is white birch but other species of birch and alder are also affected. At low populations, the insect causes leaf spotting and foliage discoloration and is merely an aesthetic problem. However, when populations are high, the discoloration becomes serious and repeated attacks by the insect cause decline in vigor, loss of growth, and death of young trees.

In 1989, in New Brunswick, birch casebearer populations remained largely unchanged from 1988 levels and caused mostly light foliage browning of white birch and, to a lesser extent, of wire birch and yellow birch over much of the Province, interspersed with areas of moderate browning. Birch casebearer damage at moderate levels was most common in Gloucester County but also occurred in Kent, Queens, Kings, Sunbury, and Carleton Counties. The average amount of white birch foliage discoloration in the areas affected was 20%, while the most serious browning occurred at Jacksontown, Carleton County (69%).

In Nova Scotia, birch casebearers were present throughout the Province but at levels lower than last year. Foliage discoloration was mainly trace or light on white birch, and only trace on wire birch, yellow birch, and alder. Average foliage discolora-

tion on white birch was 13%, and the most serious browning, 63%, was recorded at Emerald, Inverness County.

In Prince Edward Island, populations of birch casebearer were much higher than in 1988 and considerable severe and moderate foliage browning, mostly of white birch, occurred throughout much of the Province. Browning was severe at Glenwood, Greenmount, Baltic (on wire birch), and Cascumpec in Prince County; near Brackley, Cavendish, and Pleasant Cove in Queens County; and at Dundas and near St. Teresa in Kings County. Moderate browning of white birch occurred at many locations in all three counties. The average foliage browning of white birch was almost 50% (19 locations) with Prince County 59%, Queens County 52%, and Kings County 41%. Speckled alder was also affected in many areas and moderate discoloration occurred. Repeated severe discoloration in the past few years at Watervale, Queens County killed about 10% of the alder in that area.

Birch Leafminer, *Fenusa pusilla* (Lep.), an introduced insect first observed in 1923 in Connecticut, has spread throughout Canada from Newfoundland to Alberta. The birch leafminer is a perennial pest in the Maritimes, preferring wire birch but also commonly found on white birch.

In 1989, leaf browning of wire birch and, to a much lesser degree, white birch occurred throughout the Maritimes. However, populations were generally low and, with the exception of Nova Scotia, only trace or light leaf discoloration occurred. In Nova Scotia, light and moderate foliage damage was common and in a few areas severe browning was observed. The highest level of wire birch browning was recorded at Sable River, Shelburne County, where 77% of the foliage was affected.

Ambermarked Birch Leafminer, *Profenusa thomsoni* Konow, was again found in several areas in southern New Brunswick but caused only trace or light foliage browning. The insect was observed in only two areas in Nova Scotia and was not seen in Prince Edward Island. The most intense browning occurred at Carsonville, Kings County, New Brunswick, where 29% of the foliage was affected on all white birch trees in the area.

Birch Skeletonizer, *Bucculatrix canadensisella* Cham., outbreaks occur periodically in the Maritimes. The insect prefers white birch but other species of birch are also subject to attack. An outbreak reported in 1977 covered extensive areas in Nova Scotia and eastern Prince Edward Island. Outbreaks occurred again in 1985 and resulted in moderate or severe foliage discoloration on Cape Breton Island, Nova Scotia, in parts of southeastern New Brunswick and in central Prince Edward Island. The outbreak persisted on Cape Breton Island in 1986 but subsided significantly in 1987 and only scattered patches of moderate foliage discoloration were observed. In 1988, birch skeletonizer was of some consequence only in Nova Scotia where both the incidence and intensity of foliage discoloration increased over previous levels.

In 1989, skeletonizing of white birch leaves by this insect remained at the same intensity as in 1988, however, the foliage browning was more widespread than during the previous year in Nova Scotia. Foliage browning was very common on Cape Breton Island and in northern Antigonish County, with patches of affected stands found elsewhere in the Province. Discoloration was mostly in the moderate category (an average of 44% of the foliage was affected) interspersed with areas of either severe or light browning. The most serious foliage damage was recorded in Neils Harbour, Victoria County where 96% of the foliage turned brown, and at St. Peters, Richmond County with 91% foliage browning. Severe and moderate discoloration also occurred in the Card Hill Lake area of Lunenburg County. No damage was present in either New Brunswick or Prince Edward Island.

On Larch

Larch Casebearer, *Coleophora laricella* (Hbn.), an introduced species, is considered by some to be second in importance only to the larch sawfly

as a foliage feeder on larch. The insect is usually present, but widespread, persistent outbreaks have not occurred in recent years. Populations are regulated by natural control factors, including the introduced parasites *Chrysocharis laricinellae* (Ratz.) and *Agathis pumila* (Ratz.), and by weather conditions. In the past, populations were high in 1943, 1952, 1959, and 1985. Widespread defoliation occurred over much of Nova Scotia in 1985, and was especially extensive and severe in the western half of the Province. Since then, populations of the larch casebearer have been much reduced and moderate and severe defoliation occurred only on individual or small groups of trees.

In 1989, there was a reversal of recent population trends: the insect was common in all three provinces and, although needle damage in most places was confined to individual or small groups of trees, considerable foliage browning occurred in early summer throughout the Maritimes.

In New Brunswick, browning was mainly light or trace but moderate browning occurred at some locations in Charlotte, Carleton, Madawaska, Gloucester, Northumberland, Kent, and Queens Counties.

In Nova Scotia, most of the needle discoloration was in the moderate or light category, with an average of 35% of the shoots affected, but numerous patches of severe browning also occurred.

In Prince Edward Island, scattered trees were severely discolored from Camp Tamawaby through Wellington to near Miscouche in Prince County. Trees were similarly affected in a plantation east of Wellington. Moderate browning occurred at several locations in Prince and Queens Counties and lesser intensity was recorded elsewhere in the Province.

On Poplar

Poplar Serpentine Leafminer, *Phyllocnistis populiella* Cham., an insect found throughout Canada, mostly on trembling aspen, has a habit of wandering inside the leaf, taking sharp turns and doubling back, hence its name. Affected leaves take on a silverish-gray hue and when populations are high the affected stand has a silvery appearance. The damage potential of this insect is uncertain but the literature reports that heavy, persistent attacks by this leafminer result in growth loss and can lead to tree mortality.

The insect, while present throughout the Maritimes, was not of concern until 1976, when varying levels of foliage discoloration occurred in northeastern New Brunswick and in Albert and Queens Counties in the southern part of the Province. By 1981, a major infestation existed throughout northern and central New Brunswick, causing trembling aspen over large areas to become silver-grey in appearance during the summer. The outbreak has persisted over much of the same area since that time, with expansion to the south in recent years.

In 1989, serpentine leafminer populations were high in New Brunswick, and generally low in Nova Scotia and in Prince Edward Island.

In New Brunswick, high populations again caused the characteristic silverish-grey appearance of trembling aspen stands throughout northern New Brunswick and, to a much lesser extent, the southern half of the Province. The level of foliage attack has increased over that observed in 1988. In the counties of Victoria, Madawaska, Restigouche, Gloucester, and Northumberland, comprising an area nearly half that of the Province, an average of 61% of the leaves on 98% of the trees were affected, a significant increase from 43% of the foliage affected on 91% of the trees last year. In the ten southern counties, 12% of the foliage was affected on 64% of the trees, similar to the levels observed a year earlier. The effects of repeated severe attack on trembling aspen are becoming noticeable in the northern parts of New Brunswick. Leaves are much smaller than normal, the trees have a generally unhealthy appearance and twig dieback is evident in some areas

Foliage discoloration was observed in both Nova Scotia and Prince Edward Island, however, infestation levels were low, usually less than 5%. The highest population was observed near Greenmount, Prince County, Prince Edward Island,

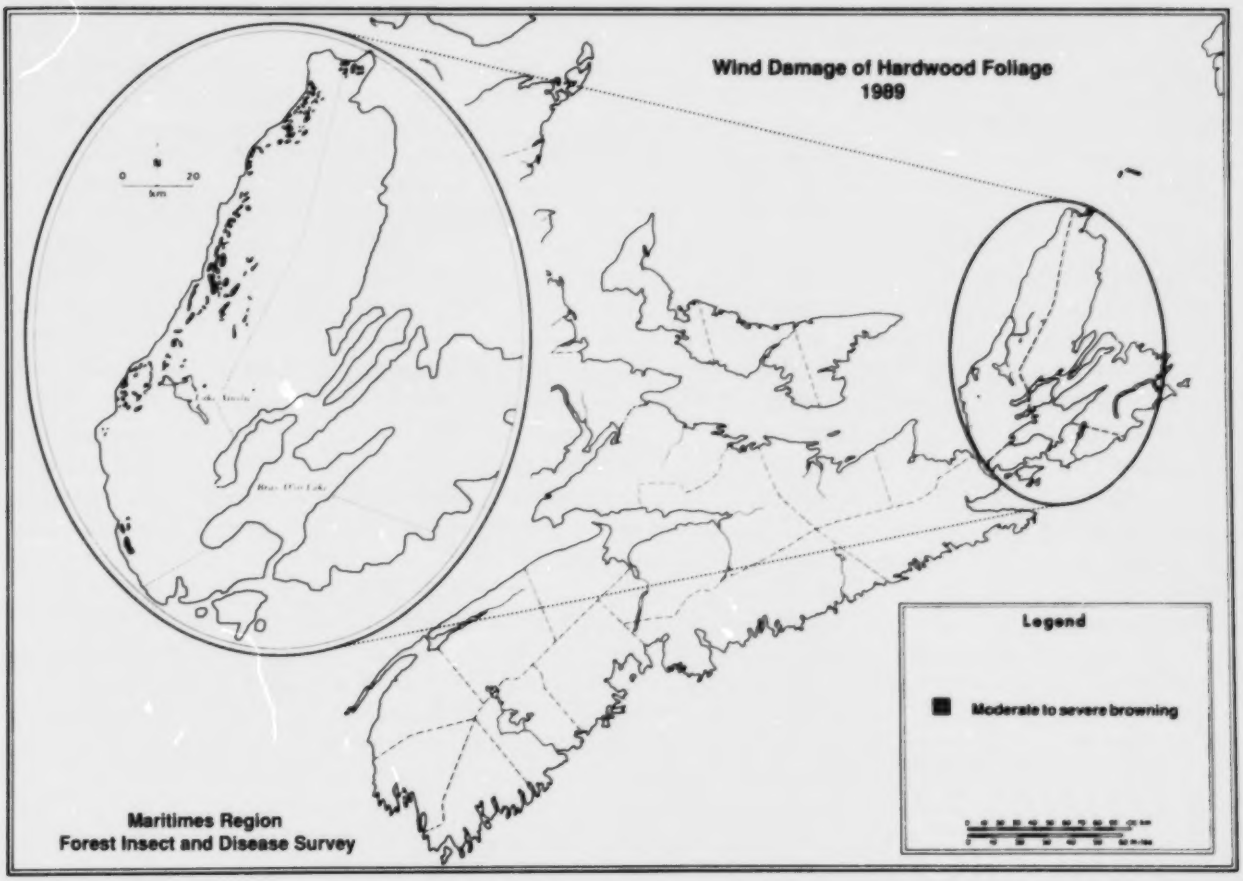


Figure 5.

where 11% of the leaves were affected on 60% of the trees.

WIND DAMAGE IN NOVA SCOTIA

Wind damage, mainly in the form of foliage injury, occurred on both hardwoods and conifers in various areas of eastern Nova Scotia. Damage was most serious on Cape Breton Island, where severe and moderate foliage browning of most hardwood species occurred at the end of June in a coastal strip along the entire length of Inverness and the northern tip of Victoria Counties (Fig. 5). Stands were affected mostly on the upper elevations of hills and along ridges. The area affected was approximately 20,000 ha of which 6,300 ha was severe and 8,700 ha moderate foliage browning. Browning was most severe on sugar maple, but red maple, birch, beech, alder, and cherry were also discolored. Damage to conifers was light. Most of the affected leaves showed signs of physical damage, being torn or shredded to various degrees, while others exhibited symptoms of water stress. The extensive damage was almost certainly the result of strong southeasterly winds blowing across Cape Breton Island, recorded a few days before foliage browning became evident. Leaf browning caused by the wind was compounded on maple by the presence of anthracnose, a leaf disease caused by the fungus *Kabatiella apocrypta* (Ell. & Ev.) Arx.

The largest area affected on mainland Nova Scotia was observed around Melrose, Guysborough County where trees suffered various degrees of damage.

Table 9. Summary of sugar maple crown dieback ratings in New Brunswick and Nova Scotia for 1988 (data from NASMDP).

Location	Stand Type (a)	No. Trees Sampled	Percent in 0-10% Dieback Class
New Brunswick			
Bathurst	SB	40	92.5
Lac Baker	SB	68	94.1
Lac Baker	NSB	50	94.0
New Denmark	SB	108	99.1
New Denmark	NSB	45	100.0
Williamsburg	SB	64	79.7
Bristol	SB	91	96.7
Bristol	NSB	52	98.1
Albert	SB	76	90.8
Albert	NSB	81	95.1
Nova Scotia			
Amherst	SB	97	100.0
Amherst	NSB	169	100.0

(a) SB = sugar bush; NSB = non-sugar bush

Some of the sugar maple stands affected were in maple syrup production areas and the effect of severe foliage browning caused considerable concern among the operators

SUGAR MAPLE DECLINE

Decline of sugar maple in eastern North America remained the focus of considerable research, attempting to explain the causes of widespread deterioration which has occurred over extensive areas during recent years. Although the decline is not restricted exclusively to sugar maple, it is the most seriously affected hardwood species and there has been great concern about the effects of the decline on the maple syrup industry and other forestry-related activities. Periodically occurring, unexplained forest declines have been documented throughout the history of eastern North American forests. It remains to be seen whether the current condition, with its often variable symptoms, is the result of a natural fluctuation in a dynamic ecosystem or is caused by some other, possibly man-made phenomenon.

In the Maritimes, although some stands were found in deteriorating condition during surveys in 1986 and 1987, no widespread decline was evident. In 1989, suspect stands were again investigated, including an area of about 300 km^2 west of Napadogan, York County, New Brunswick, where patches of both sugar maple and red maple showed decline symptoms. Mature and semi-mature trees were the most affected, especially in areas of old cuts where red maple trees were left standing.

In Nova Scotia, significant changes in tree condition were recorded between 1988 and 1989 on four sugar maple monitoring plots established in 1982. Overall, 44% of trees showed an increase in the amount of dieback. While the levels of dieback are still not considered to be serious, the trend is of concern. Monitoring will continue to

Table 10. Summary of sugar maple crown dieback ratings in Prince Edward Island for 1989

Location	County	No. trees sampled	Percent in 0-10% dieback class
St. Hubert	Prince	19	100
Haliburton	Prince	16	100
Middleton	Prince	38	100
Caledonia	Queens	44	100
Lewes	Queens	45	98
Appin Rd. E.	Queens	36	100
Appin Rd. W.	Queens	16	100

determine if these trees continue to deteriorate or recover in the next few years.

The North American Sugar Maple Decline Project (NASMDP) continued in 1989. Field data was collected for the second year by the Forest Insect and Disease Survey and the New Brunswick Departments of Environment and Natural Resources. This project brings together investigators from four Canadian provinces and seven states of the United States in an attempt to describe where maple decline exists, what is the rate of deterioration or recovery of trees, and if changes in tree condition relate to levels of atmospheric pollution. Both managed sugar bushes and undisturbed stands are assessed. In 1989, the 10 New Brunswick and two Nova Scotia plots were augmented with two additional plots to complete the pairing of sugar bush and non-sugar bush plots. Tree condition was also assessed using NASMDP methodology, in two independent (i.e., non-paired) areas east of St. Quentin, Restigouche County, where there is considerable interest in expanding the maple sugar industry. Trees in these areas were in better condition than the provincial average.

The NASMDP data collected during 1988 showed that 94% of sugar maple in sugar bushes and 99% of those in natural stands had no more than 10% dieback. Some dieback within a stand is considered normal, thus the amounts found, on average, are not significant. The percentage of trees within the 0-10% dieback class ranged from 80% to 100% (Table 9). Statistical analysis showed that there were no significant differences between sugar bush and non-sugar bush stands in dieback or in either of two other decline symptoms, leaf density and discoloration. A more critical analysis will be possible as "change" data becomes available from the 1989 measurements.

In Prince Edward Island, although no sites were available which met the criteria set for the NASMDP, seven independent plots were established in 1989 and trees were assessed using NASMDP methodology. An average of more than 99% of the trees on these plots had 0-10% dieback, suggesting that, for the most part, sugar-maple in the Province is in very good condition (Table 10).

DUTCH ELM DISEASE

Dutch elm disease, caused by the fungus *Ceratocystis ulmi* (Buism.) C. Moreau, was of major concern in all three Maritime provinces in 1989 (Fig. 6).

In New Brunswick, the disease is present wherever elm trees are found. The resurgence of infection, commencing in 1984, continued, especially along river valleys. Numerous infected and dying trees, both residual old trees and young saplings, were observed throughout the Province in 1989.

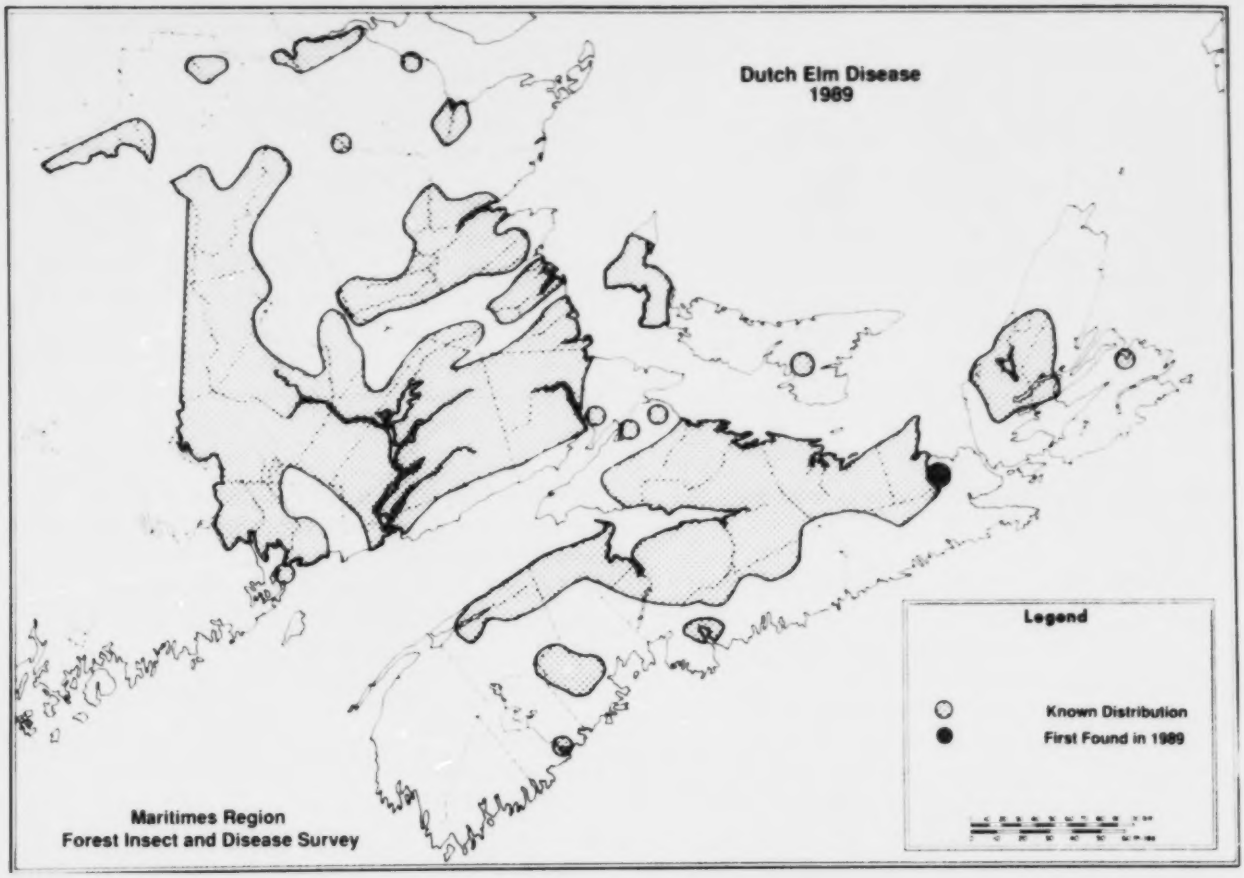


Figure 6.

In Nova Scotia, the intensification of the disease, evidenced by great numbers of dead and dying elm trees, continued within outbreak areas where sanitation is not practised, especially in Annapolis, Kings, Hants, Colchester, and Antigonish Counties. There was only a marginal extension in the known distribution of the disease in 1989 with the discovery of two infected trees at Black Avon, Antigonish County.

In Prince Edward Island, the disease was first discovered in 1979 in a small area of north-central Prince County. The initial discovery was followed by an immediate and vigorous sanitation cut by the provincial government. No infected trees were found in 1980 and 1981, one infected tree was identified and removed in 1982, none were found in 1983 and 1984, one tree was found in 1985 and two trees in 1986. In 1987, infected trees were found at eight locations at widely separated areas of western Prince County. Although the incidence of infection was generally low, the spread of the disease in this part of the Province was of concern. In 1988, the discovery of a newly infected mature elm tree at Alberry Plains, Queens County extended the distribution of Dutch elm disease eastward by approximately 90 km. The infected tree was promptly removed by the owner to minimize the danger of creating a new infection center in the eastern part of Prince Edward Island. In 1989, there were no diseased trees in this area and infection occurred only in Prince County within the known distribution of the disease, at O'Leary and at Trout River.

In Fredericton, the progress of Dutch elm disease and the effects of the control program have been monitored since 1961, when the disease was first

found in the city. The 22 trees killed by the disease in 1989 represented 0.7% of the current elm population within the Dutch Elm Disease Management Area and the lowest annual loss since 1972. The trend of decreasing losses has continued since 1980 when the loss rate peaked at 7.8% after a steady climb during the 1970s. The annual loss rate during the 1980s was as follows:

1980	7.8%
1981	5.3%
1982	3.0%
1983	2.4%
1984	1.1%
1985	1.3%
1986	0.8%
1987	1.0%
1988	1.0%
1989	0.7%

Cumulative loss to date amounts to 29.7% of the original urban elm stand. Loss figures may be inflated, even at these low levels, as some of the 22 trees lost were low quality, small, hedgerow trees, unlikely to have been part of the 1961 tree count, but they were still used in calculations as part of the loss from the original population figure.

No systematic survey was conducted by the Forest Insect and Disease Survey in 1989 for elm bark beetles, the carriers of Dutch elm disease, except in Fredericton, where populations of the native elm bark beetle, *Hylurgopinus rufipes* (Eichh.), remained low. The European elm bark beetle, *Scolytus multistriatus* (Marsh.), was not captured in 1989. This insect, the most important vector in spreading Dutch elm disease in the United States, has not been a factor to date in Fredericton. Single adults were captured in pheromone traps in 1982 just south of the City and in 1983 at Tay Creek, some 30 km to the north. In 1986 and 1987, single adults were captured in Fredericton on sticky band monitoring traps.

SEED ORCHARD PESTS

The establishment of seed orchards created a new category of high value areas in the Maritimes Region. Seed orchards and seed production areas are as important to nursery programs as seedling production in nurseries is to plantation programs. Consequently, anything that interferes with seed orchards also affects most other phases of forestry operations aimed at future wood production. Insects and diseases in seed orchards have the potential to seriously affect seed production, either directly, by destroying seed or cones, or indirectly, by affecting condition of trees, thus interfering with their ability to produce seed.

The number of samples submitted to FIDS from seed orchards remained approximately the same as in 1988 although there was a noticeable change in the pest species sampled. Most orchard managers have become familiar with the more common pests and send in samples only of those they cannot identify.

The following, which is not intended to be all inclusive, was prepared in cooperation with R.F. Smith and J. Sweeney, Forestry Canada - Maritimes Region, to give an overview of problems encountered in seed orchards in 1989.

In June 1989, Forestry Canada - Maritimes Region hired an entomologist, Dr. Jon D. Sweeney, to work on cone and seed pests. He spent much of the summer familiarizing himself with Maritime seed orchards and making the acquaintance of orchard managers.

The cone crop in 1989 was not as heavy as in 1988. However, there were almost as many cones collected, as more orchard trees are beginning to produce, a pattern which can be expected to continue for the next five to ten years.

Cone and Seed Insects

Spruce cone maggot, *Strobilomyia neanthracinum* Michelsen (formerly *Hylemya anthracina* (Czerny)), damage was again found at low to moderate levels in all of the cone-bearing white spruce orchards in Nova Scotia, as well as in two orchards in New Brunswick. In one New Brunswick black spruce seedling seed orchard, 16% of the cones were infested (five cones per tree from five trees collected over six dates).

Coneworms, *Dioryctria* sp., were found in cones of all four spruces and jack pine, in various seed orchards in the Region. Fir coneworm, *Dioryctria*

abietivorella (Grt.), damage was at moderate levels in two black spruce seedling orchards in New Brunswick.

Spruce cone gall midge, *Dasineura canadensis* Felt, and spruce cone axis midge, *D. rachiphaga* Tripp, were both found in one orchard each of red and white spruce in Nova Scotia. The spruce cone axis midge damaged 12% of the cones (sample of 10 cones per tree from five trees) in one black spruce orchard in New Brunswick.

Other Insects

Spruce budworm, *Choristoneura fumiferana* (Clem.), caused moderate cone losses in one black spruce seedling seed orchard in New Brunswick for a second consecutive year. A cooperative study between New Brunswick International Paper, New Brunswick Dept. of Natural Resources and Forestry Canada - Maritimes Region was started in 1989 to begin to address this problem.

Spruce micro moth, *Endopiza piceana* (Free.), was associated with light cone damage in one white spruce orchard in Nova Scotia.

Damage from the ***spruce bud scale***, *Physokermes piceae* (Schr.), was light in one white spruce orchard in New Brunswick.

A number of ***sawflies*** were found in relatively low numbers in one white pine, one Japanese larch and several white spruce orchards. These included a webspinning sawfly, *Cephalcia* sp. (*Pamphiliidae*), the white pine sawfly, *Neodiprion pinetum* (Nort.), a larch sawfly, *Anoplonyx* sp., and the yellowheaded spruce sawfly, *Pikonema alaskensis* (Roh.).

Light damage by the ***spruce budmoth***, *Zeiraphera canadensis* Mut. & Free., occurred in two white spruce orchards, one in New Brunswick and one in Nova Scotia, while *Zeiraphera* sp. damage also occurred in one Nova Scotia red spruce orchard.

The ***w-marked cutworm***, *Spaelotis clandestinis* (Harr.), caused moderate early season defoliation in a white spruce orchard in New Brunswick. This pest generally feeds on grass and similar vegetation and does not feed so extensively on trees, especially upper crown foliage. However, this spring, the cover crop had not yet "greened up" when these insects were active, hence we speculate that they moved to the only available food source, the elongating white spruce shoots. An egg mass of another cutworm, *Noctua pronuba* (L.), was collected in a Norway spruce seed orchard in Nova Scotia.

Other insects causing trace or light defoliation included the ***larch casebearer***, *Coleophora laricella* (Hbn.), in a Japanese larch seed orchard; the ***eastern blackheaded budworm***, *Acleris variana* (Fern.), in one black spruce orchard, and the ***chameleon caterpillar***, *Anomogyna elimata* (Gn.), in one jack pine orchard.

Cones in one New Brunswick tamarack orchard were infested by a complex of four insects including; *Archips* sp., *Coleotechnites* sp., *Resseliella* sp., and *Hymenoptera* sp.

Aphids and Mites

Aphids were found in all of the Maritime seed orchards in 1989, while mites were most prevalent in larch orchards. The species and population levels varied considerably between orchards.

Populations of ***spider mites***, *Tetranychidae*, were high in one tamarack orchard in New Brunswick with approximately 80% of the trees being attacked. Low populations were found in two other tamarack orchards and one red spruce orchard.

Gall adelgids, *Adelges* sp., were present in low to moderate populations in all of the tamarack orchards in the Maritimes. Aphids present in spruce orchards included *Cinara* sp., a conifer aphid, the ragged spruce gall adelgid, *Pineus similis* (Gill.); the eastern spruce gall adelgid, *Adelges abietis* (L.); and a single find which was tentatively identified as a twig aphid, *Mindarus* sp. Aphids present in pine orchards included *Cinara* sp. and the pine bark adelgid, *Pineus strobi* (Htg.).

Diseases

The spring and early summer of 1989 was relatively cool and damp, especially in much of Nova Scotia. While the cone and seed diseases were down considerably from 1988, Sirococcus shoot blight, *Sirococcus conigenus* (DC.) P. Cannon & Minter, was present in all of the spruce orchards in Nova Scotia. Damage was especially severe in one clone bank.

Scleroderris canker, *Gremmeniella abietina* (Lagerb.) Morelet, was present in moderate to high levels for the third consecutive year in a New Brunswick jack pine seedling seed orchard despite pruning of the lower limbs in 1987.

Spruce needle rust, *Pucciniastrum americanum* (Farl.) Arth., was present in all white spruce orchards in the Region, although mostly at low to trace levels. Spruce cone rust, *Chrysomyxa pirolata* Wint., was found only on a few spruce cones at seed orchards throughout the Region.

Eastern dwarf mistletoe, *Arceuthobium pusillum* Peck, was found for the first time in a white spruce clonal orchard in Nova Scotia.

Armillaria root rot, *Armillaria mellea* (Vahl ex Fr.) Kummer, continued to kill trees in black spruce seedling seed orchards, planted on cutovers, one in Nova Scotia and three in New Brunswick.

Needle rusts on various hosts were present but in insignificant amounts.

Globose gall rust, *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka, was again a problem in several jack pine seed orchards in New Brunswick. Removing galls by pruning infected limbs continues to be a routine practice in jack pine orchards.

Mammals

Mouse damage was light in 1989 largely due to the effective control programs implemented in 1988. Feeding by porcupines, snowshoe hare, and deer, was minimal in 1989.

Abiotic causes

Moderate foliage burn occurred as a result of severe drought following a ***herbicide*** application in one black spruce seedling orchard in New Brunswick. The problem was most severe for trees in the drier portions of the orchard and for which a heavy, 6 ml black plastic was used as a mulch. Trees in blocks where the soil was more moist (closer to a river) did not burn. The affected areas of the orchard were irrigated following the appearance of the damage. ***Fertilizer burn*** was also a problem in a seed orchard in Annapolis County, Nova Scotia, where light and moderate foliage browning occurred on almost one third of the trees in a section of the orchard.

NURSERY AND GREENHOUSE PESTS

Seedling production is essential to avoid or minimize predicted shortfalls in wood production. It is as important to plantation programs as seed production is to nurseries. Pests affecting nursery production increase the cost of meeting the objectives of forestry.

Of the conditions encountered in 1989 in nurseries and greenhouses, some are mentioned here because of their importance, while others demonstrate that no facet of forestry is without problems. Although some of the insects and diseases mentioned may appear insignificant, they did occur despite constant vigilence and continuing control measures. Good nursery practices have limited their damaging potential. Abiotic problems were widespread and severe in 1989. Considerable seedling losses occurred and many "surviving" trees were injured to some extent.

The following, which is not intended to be all inclusive, was prepared in cooperation with R.D. Hallett and T.W. Burns, Forestry Canada - Maritimes Region, to give an overview of problems encountered in nurseries and greenhouses in 1989.

Diseases

Gray mold, *Botrytis cinerea* Pers. ex Fr., was very heavy on 300,000 one-year-old white spruce con-

tainer stock overwintered at a Nova Scotia nursery. Gray mold was common throughout the Region as a secondary infection whenever nursery stock was stressed or injured by abiotic problems.

Sirococcus shoot blight, *Sirococcus conigenus* (DC.) P. Cannon & Minter, was found in both spring and summer greenhouse crops of white spruce container stock at a Nova Scotia nursery. Vigilance and control measures prevented serious losses.

A ***seedborne fungus***, *Fusarium* sp., capable of causing top blight and damping off, was common and caused seedling mortality in Norway spruce germinated from an imported seedlot at a Nova Scotia nursery.

Insects

Pine bark adelgid, *Pineus strobi* (Htg.), was present on three-year-old white pine bareroot stock in a New Brunswick nursery.

Spruce budmoth, *Zeiraphera canadensis* Mut. & Free., caused damage on two-year-old white spruce bareroot hedging material in a Nova Scotia nursery.

Spruce budworm, *Choristoneura fumiferana* (Clem.), was the probable cause of damage on black spruce container seedlings in a greenhouse.

Abiotic factors

Abiotic factors, singly or in combination, resulted in more seedling losses than insects and diseases combined again this year. Losses were substantial, many millions of seedlings died or were injured during the year.

Although not readily apparent until spring, ***overwintering injury*** was common in most nurseries in the Maritimes. Insufficient snow cover during periods of extreme cold in late fall and early winter caused widespread root mortality which only became apparent after the stock broke dormancy in the nursery or in newly established plantations. Extensive overwintering root damage was present on red spruce, black spruce, and white spruce container stock at two nurseries in Nova Scotia. Similar damage was also found in New Brunswick nurseries. ***Seedlings grown too large*** for the container with poor roots as a result of excessive fertilization are prime candidates for overwintering injury. Crops overwintered in this condition are extremely vulnerable to damage by ***gray mold,*** *Botrytis cinerea,* and other fungi while overwintering.

Abiotic problems in 1989 also included ***watering problems, heat lesions***, and ***frost damage***.

CHRISTMAS TREE PESTS

Many pests of balsam fir Christmas trees are mentioned elsewhere in this report. The balsam gall midge and the balsam twig aphid are discussed here because of their widespread occurrence both in Christmas tree areas and in natural stands, and because they affect the quality and, consequently, the value of Christmas trees.

The following, which is not intended to be all-inclusive, was prepared in cooperation with G. Estabrooks and D. Marks, Forestry Canada - Maritimes Region, to give an overview of problems encountered in Christmas tree production areas in 1989.

Balsam gall midge, *Paradiplosis tumifex* Gagné, population levels and resulting needle loss, were generally low again throughout the Maritimes but increased slightly and were more widespread than in 1988.

In New Brunswick, an average of 9% of balsam fir needles were affected on 69% of the trees at 63 locations assessed by the Forest Insect and Disease Survey, an increase from 3% of the needles on 35% of the trees found last year. Infestation levels were moderate or severe in some areas along the Tobique River from near Nictau Lake to Perth in Victoria County and severe damage occurred on natural balsam fir trees in a 200 ha spruce plantation in Prince William, York County, where 30-100% of the needles were affected on more than 80% of the trees.

Infestation levels by the balsam gall midge were also determined at 861 locations by the New Brunswick Department of Natural Resources. Of these, 41% were negative, 1-10% of the needles were affected at 56% of the locations; the infestation level was in the 11-20% range at 3% of the locations; and 20% or more of the needles were affected at 5 locations (less than one percent). These figures, although low, are once again higher than those of a comparable survey in 1988. They also indicate that balsam gall midge is becoming more generally distributed, 41% of negative samples in 1989 being down from 70% in 1988 and 90% in 1987. Although the above represents samples from larger, older trees, used to determine spruce budworm populations, the figures are a good indication of the distribution of balsam gall midge populations in the Province in 1988.

In Nova Scotia, an average of 4% of balsam fir needles were affected on 30% of the trees at the 48 locations assessed by the Forest Insect and Disease Survey, an increase from the 2% of needles affected last year. The highest infestation level observed in 1989 was 30% at Hardwood Hill, Pictou County, while, in 1988, the highest observed infestation was only 14%. Small pockets of trees in a few Christmas tree lots suffered severe or moderate damage in Antigonish County.

A special survey by the Nova Scotia Department of Lands and Forests conducted at 391 locations found balsam gall midge infested needles to be at light (6-29%) levels in 6% of the areas, an increase from the 2% in 1988, while in the remaining 94% of the areas, infestation levels were classified as trace (0-5%).

In Prince Edward Island, balsam gall midge was present throughout the Province. Infestation levels were low but as many as 80% of the trees were affected in one area of Kings County. The highest infestation level recorded was 8%, northwest of Crossroads, Queens County, where half of the trees were affected.

Balsam twig aphid, *Mindarus abietinus* Koch, infestations were common throughout the Maritimes. Damage increased in Prince Edward Island, decreased in Nova Scotia, and remained about the same in New Brunswick; however, damage levels were generally light with a few areas suffering moderate shoot damage.

In New Brunswick, an average of 10% of balsam fir shoots were affected on 50% of the trees assessed at 45 scattered locations. These figures are similar to the 13% of shoots affected on 50% of the trees in 1988. The highest infestation, 32% of shoots on 70% of trees, was recorded at Rollingdam, Charlotte County. There was an increase in the distribution of the aphid, as indicated by the survey conducted by the New Brunswick Department of Natural Resources. Twig aphid was present at 50% of the 861 locations assessed, compared to 39% positive locations in 1988 and 16% in 1987.

In Nova Scotia, balsam twig aphid was common but intensity of attack averaged only 7% (range 0 to 53%). The highest infestation was recorded at Stephen Mountain, Cumberland County. A survey by Nova Scotia Department of Lands and Forests at 391 locations found moderate infestations at only 13 locations. In over 80% of the areas, balsam twig aphid was either not found or affected less than 5% of the shoots, compared to 62% of such areas last year.

In Prince Edward Island, there was an increase in balsam twig aphid populations. Damage was much more common than last year and damage levels were also generally higher. As much as 69% of the shoots were affected on about half the trees in an area of the Auburn Demonstration Woodlot, Queens County. Light damage occurred in several areas in all three counties in the Province.

SPECIAL SURVEYS

Several forest pest surveys are carried out annually that are not necessarily related to forest pests of major importance. Considering the implications this information may have in forest management, summaries and results of these special surveys have been included here in our annual report.

ACID RAIN NATIONAL EARLY WARNING SYSTEM

Acid rain means more than just rain with a lower than normal pH. It includes any form of acid precipitation, both wet and dry, and air pollutants of different kinds. These, alone or in combination, directly or indirectly affect the health of Canada's forests by interfering with their normal development, the production of wood, or their role in providing a healthy environment.

Concern over the future of Canadian forests has intensified as a result of the alarming tree mortality observed in other parts of the world. The Acid Rain National Early Warning System (ARNEWS) came into being in early 1984, when Forestry Canada established a national program to detect, clearly and accurately, early signs of acid rain damage to Canada's forests before such damage becomes obvious.

The ARNEWS system consists of (1) permanent plots, where detailed measurements and observations are made at regular intervals; (2) condition appraisal points where trees are checked for symptoms and specific measurements (such as needle retention) are made; and (3) continuous general surveillance for signs of changes in the health and condition of the forest.

ARNEWS Plots

Permanent plots are maintained in all Regions of Canada to monitor:

a. the condition and changes in the condition of the forest stand;
b. the presence and fluctuation of biotic and abiotic factors that affect the condition of the forest (insects, diseases, stand changes, temperature etc.);
c. the changes and symptoms that indicate factors not attributable to the above which could conceivably be early signs of acid rain damage; and
d. the effect of acid rain on the condition of the various economically important tree species.

The rationale behind the above is that, without close monitoring of all the factors mentioned, the expected, initially subtle, effects of acid rain cannot be isolated and identified.

In the Maritimes Region, 17 permanent ARNEWS plots, representing the important forest species and geographical areas, were established. Fifteen of the plots were established in 1984 and two additional plots were established in northwestern New Brunswick in 1985 at the request of and in cooperation with Fraser Inc.

In 1989, all 17 plots were visited monthly from June to September to: determine forest insect and disease conditions; detect "acid rain" symptoms (if any); observe seed crop and premature fall discoloration; and collect ground vegetation samples. In August, detailed assessments of all plots were carried out following the procedures developed by the Maritimes FIDS unit for the national system (DPC-X-25, Magasi, 1988).

Needle Retention by Conifers

In addition to the work on permanent plots, the results of observations for signs of possible acid rain damage were recorded for most of the 374 locations where detailed pest condition assessments were made. Special attention was directed at the number of years of needle retention on coniferous species. A summary of some of these observations is presented in Table 11. It is apparent that the percentage of needles retained decreases with the age of foliage and the rate of the decrease varied among tree species and between provinces. It is important to realize that the figures represent provincial averages and, more importantly, that at least some of the loss is definitely attributable to feeding by defoliating insects. Similar information has been collected annually since 1985 in our effort to build a data base which will allow analysis of possible changes.

Unexplained Situations

Forest Insect and Disease Survey personnel are always on the lookout for unusual or unexplained forest conditions, some of which could conceivably be the result of acid rain damage. Unexplained

Table 11. Retention of needles produced in different years by various coniferous trees in the Maritimes Region - 1989

Species	Province	No. of observ-ations	Needles retained of the needles produced in the year indicated (%)							
			1989	1988	1987	1986	1985	1984	1983	1982
Balsam fir	New Brunswick	109	96	87	80	68	61	43	26	15
	Nova Scotia	60	100	97	92	84	71	55	27	9
	Prince Edward Is	8	100	99	94	88	75	48	19	3
White spruce	New Brunswick	45	98	94	89	76	62	44	25	14
	Nova Scotia	52	99	97	91	81	62	41	21	9
	Prince Edward Is.	22	90	91	88	78	62	44	25	7
Black spruce	New Brunswick	35	100	97	91	81	69	52	39	24
	Nova Scotia	27	100	99	91	84	61	47	29	15
	Prince Edward Is.	8	100	100	94	86	59	35	5	6
Red spruce	New Brunswick	39	99	98	95	86	73	56	39	24
	Nova Scotia	37	100	95	90	80	62	42	20	7
Spruces (combined)	New Brunswick	119	99	96	92	81	68	51	34	21
	Nova Scotia	116	100	97	91	82	62	43	23	10
	Prince Edward Is.	30	95	96	91	82	61	40	15	7
Red pine	Nova Scotia	3	100	93	80	33	0	0	0	0
	Prince Edward Is.	2	100	100	90	5	0	0	0	0
White pine	Nova Scotia	7	100	73	33	0	0	0	0	0
Jack pine	New Brunswick	4	100	98	85	23	23*	13*	0	0
	Nova Scotia	2	100	70	45	45	0	0	0	0
Pines (combined)	New Brunswick	4	100	98	85	23	23*	13*	0	0
	Nova Scotia	12	100	79	53	26	0	0	0	0
	Prince Edward Is.	2	100	100	90	5	0	0	0	0
Hemlock	Nova Scotia	4	100	95	83	65	25	5	3	3

* Jack pine at one location with six age-classes of needles.

Table 12. Condition of white birch along the Bay of Fundy in New Brunswick on permanent plots, 1982-1989

Tree Condition Class	Percentage of trees in class							
	1982	1983	1984	1985	1986	1987	1988	1989
No dieback	92.9	83.7	64.0	45.3	14.5	--	--	--*
Twig dieback only	1.5	8.6	24.9	34.9	47.3	42.6	38.0	43
Twig and branch dieback	4.7	6.0	7.8	14.4	31.3	49.8	54.0	47
Dead	0.9	1.7	3.3	5.4	6.9	7.6	8.0	10

Each plot consists of 50 tagged trees.
11 plots 1982-88
10 plots 1989
* one tree was classified as "no dieback"

forest conditions currently under observation are briefly described:

Deterioration of white birch along the Bay of Fundy

Annually recurring, early, usually severe, foliage browning and premature leaf fall along the Bay of Fundy has resulted in serious deterioration of white birch trees in this area. The cause of the condition, first reported in 1979, is not known, but insects and diseases have been ruled out and some type of pollution is suspected as the causal agent. Multidisciplinary research was initiated in 1986 to investigate possible causes, including acid rain, acid fog, and ozone.

In 1989, early foliage browning of white birch occurred again along the Bay of Fundy, both in New Brunswick and in Nova Scotia. Browning was present in essentially the same areas as in previous years.but was generally only at trace or light intensity in late August. Discoloration intensified rapidly in early September, resulting in considerable foliage browning which was, however, clearly distinguishable from autumn leaf discoloration.

Tree condition has been assessed annually on permanent plots established in 1982. Summarized results from the plots in New Brunswick are shown in Table 12. Eleven plots were assessed from 1982 to 1988. In 1989, one of the plots was lost to harvesting operations in the area.

The history of white birch deterioration along the Bay of Fundy in New Brunswick from 1979 to 1988 has been published in an information report (Magasi, 1989, M-X-175).

Foliage browning of birch, similar to that along the Bay of Fundy, also occurred in other areas in both New Brunswick and Nova Scotia.

Groups of trees exhibited various degrees of symptom intensity, while other white birch trees in the same area remained green. Discolored trees varied in size from small saplings to mature trees. Specific areas, away from the Bay of Fundy shores, where the condition was observed, were in Charlotte, York, Sunbury, Queens, Kings, Albert, and Victoria Counties in New Brunswick, Cape Breton Island, and in southern Cumberland, Colchester, Antigonish, Pictou, Guysborough, Halifax, Hants, and Kings Counties in Nova Scotia.

Condition of red spruce

In 1985, in the southern part of New Brunswick, red spruce was found to be deteriorating at many locations on Deer Island, Charlotte County. Although trees in many of these areas have been defoliated by the spruce budworm in the past, this did not adequately explain the conditions observed. In 1986, permanent observation plots, each consisting of 50 trees, were established in Charlotte and Sunbury Counties in New Brunswick and in Hants, Cumberland, and Halifax

Table 13. Condition of red spruce at four permanent plots in the Maritimes 1986-1989

Tree Condition Classes		Percentage of trees in various tree condition classes															
		New Brunswick								Nova Scotia							
		Charlotte Co.				Sunbury Co.				Hants Co.				Cumberland Co.			
		86	87	88	89	86	87	88	89	86	87	88	89	86	87	88	89
1.	Healthy, no defoliation	4	90	100	100	0	0	0	50	14	40	40	0	0	0	0	0
2.	Healthy, only current defoliation	38	10	0	0	0	56	38	18	0	0	0	46	0	0	0	44
3.	More than current but less than 25% total defoliation	50	0	0	0	64	30	50	18	46	58	54	46	12	16	22	36
4.	Total defoliation 26-50%, no bare top	6	0	0	0	28	10	4	4	36	2	6	8	74	82	72	20
5.	Total defoliation 26-50%, with bare top	2	0	0	0	8	0	2	4	4	0	0	0	14	2	2	0
6.	Total defoliation 50-75%, no bare top	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
11.	Total defoliation more than 90%, with bare top	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
12.	Dead 1 year or less	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0
13.	Dead - more than 1 year	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0

Counties in Nova Scotia to follow changes in the condition of trees. The plot in Halifax County was cut in the summer of 1987. The summary of tree conditions at the remaining four plots is presented in Table 13. Observations to date indicate an overall improvement on the plots, even though the rate of recovery appears to vary and a few trees died in the Sunbury County plot.

Condition of white spruce at Loch Katrine, Antigonish Co., Nova Scotia

Chlorotic foliage has been observed since 1985 on white spruce trees near Loch Katrine, Antigonish County, Nova Scotia, in an uneven-aged stand of about 20 hectares. The current foliage is green, but all older needles on affected trees exhibit various levels of yellowish discoloration. Not all trees in the stand are affected, but trees from all age classes show similar symptoms. Yellowing is more prominent on the upper surface of needles than on the underside. Needle retention of older foliage is less than that normally found on unaffected trees. Some of the trees have thin crowns. The cause of this condition is unknown but no insects or diseases appear to be involved. In 1988, additional white spruce trees in the general vicinity exhibited chlorotic foliage. Neither foliage nor soil samples, collected in 1987, showed major differences between affected and non-affected areas which might have explained the chlorotic foliage. However, tree growth in the affected area was drastically reduced in 1984 and this rate was maintained until 1987 when growth was measured. The average annual radial increment during 1984-1987 was reduced by 35% compared to growth in the preceding 10-year period.

In 1989, the condition was present again and the size of the affected area appears to be increasing. Yellowing is most pronounced at the tips of the one-year-old needles but is present on all older foliage as well.

PINEWOOD NEMATODE

Pinewood Nematode, *Bursaphelenchus xylophilus* (Steiner and Buhrer) Nickle, has gained worldwide notoriety in recent years, mostly because of its implications for international trade in forestry products. (Reported as *B. lignicolus* in our 1985 report.)

Nematodes are a class of "elongated, cylindrical worms, parasitic in animals or plants or free-living in soil or water" (Webster's Seventh New Collegiate Dictionary, 1970). The pinewood nematode was first identified in North America in the late 1970s and was believed to have been imported from Japan, where it has been reported to have killed trees for at least 30 years. The pinewood nematode has been reported as widely distributed in the United States and, in 1982, was reported in southern Manitoba. The nematode was found in many areas of Canada in the mid-1980s. It was first found in the Maritimes in 1986, when it was isolated from a few dead trees in New Brunswick.

The pinewood nematode is a plant-parasitic species which kills trees by rapidly multiplying in the water conducting elements, after having been introduced into the trees by some wood-boring insect, such as the sawyer beetle or the bark beetle. The actual vectors are not known but cerambycids are suspected. The affected tree, with its water supply cut off, wilts and dies within a short time. The fact that many species of nematodes may be present in trees, most of them non-pathogenic, and that the identification of these microscopic organisms is extremely difficult, has resulted in considerable confusion as to the cause of tree mortality in some areas and as to the actual distribution of the pinewood nematode itself.

In the Maritimes, the pinewood nematode (referred to earlier as the "Japanese wood nematode") has been of special concern to the Forest Insect and Disease Survey since 1980. Through general observations, forest condition assessment surveys, plantation surveys, pest extension activities, provincial cooperative surveys, and special surveys, staff have been on the lookout for symptomatic suspect trees. In the six years from 1980 to 1985, 17 such trees were located. These included red pine, Scots pine, white spruce, and balsam fir. Nematodes were extracted from some of these but none of the samples submitted were of the pinewood

nematode. Also in 1984, a number of bark beetles from stressed balsam fir were tested as possible vectors for the pinewood nematode - with negative results.

Because of the plant quarantine importance of pinewood nematode, extensive surveys have been underway to detect its presence in trees since 1985, and in its possible vectors (carriers) in 1988. The two surveys are discussed below:

Tree surveys - 1985-1989

In the fall of 1985 and during subsequent summers, a special survey was conducted in the Maritimes as part of a national effort to establish the presence and distribution of the pinewood nematode in Canada. Recently dead, old dead, and a few living trees were sampled and, from a number of locations, insects considered to be possible vectors for the nematode were also analyzed. Samples were obtained from 228 locations, 147 in New Brunswick, 55 in Nova Scotia, and 26 in Prince Edward Island.

Pinewood nematode (either form) has been identified at 27 of the 228 locations (11.8%), from 32 of the 418 trees (7.6%) sampled. The so-called "r" form has been found at five locations (2.2%) in seven trees (1.7%) sampled. All were identified from New Brunswick and all came from dead pine trees. The so-called "m" form has been found at 23 locations (10.1%), 14 in New Brunswick (9.5% of 147 locations) and 9 in Nova Scotia (16.3% of 55 locations). Two trees were infested at two locations; only individual trees were positive in the other areas. Of the 25 infested trees, 18 were balsam fir and one each of black spruce, red spruce, Scots pine, eastern white pine, and jack pine. All but one of the trees from which the "m" form was extracted were recently dead, the exception being an old-dead eastern white pine tree from Nova Scotia. No pinewood nematode (either form) was found in Prince Edward Island.

Although all infested trees were dead, it is unlikely that any of them were killed by pinewood nematode. In most cases, the cause of death was easily attributable to definite factors, such as root rot, wind-throw, mechanical damage, etc., or death due to gradual deterioration following repeated defoliation. Also, in most cases, nematode numbers in samples were far too low to have been able to significantly affect the infested trees.

Balsam fir received special attention, especially in the early part of the survey, because of the similarity in symptom expression between Stillwell's Syndrome (the sudden wilting of balsam fir trees) and the supposedly sudden wilting of conifers killed by the pinewood nematode. Pinewood nematode has been identified from only a few of the balsam fir trees that succumbed to Stillwell's Syndrome.

Vector survey - 1988

During the summer of 1988, a special pinewood nematode-vector survey was conducted in the Maritimes as part of a national effort. The purpose of the survey was to clarify the situation regarding wood inhabiting insects as possible vectors of the pinewood nematode. The question arose in connection with the potential loss of Canadian lumber exports to Europe.

Sampling was done according to an established national protocol to ensure uniformity across Canada. Insects were collected in the forest, on logs, bark- and chip-piles in mill yards. Most insects were picked up while resting, others were trapped in bottles baited with attractants, and some, mainly bark beetles, were reared in the laboratory from infested logs. Special effort was expended on repeated collection at the Nevers Brook, Kent County, N.B. area, where the "r" form of the pinewood nematode was found both in 1986 and 1987, even though in only a very few trees.

Specimens were shipped by air to ensure that they arrived alive at Memorial University, St. John's, Newfoundland, for preparation and identification.

The pinewood nematode vector survey in the Maritimes in 1988 yielded 1676 specimens, representing 38 insect species in six families. There were 260 collections from 151 locations. The

report from the contractor states that neither form of the pinewood nematode was found in any of the insects collected in the Maritimes in 1988.

Current activities

Partly in response to questions regarding the spread of pinewood nematode in "vector-infested" lumber, a study was launched to investigate the effect of grub holes on the quality of lumber by University of New Brunswick student Denise Hart. In 1989, eight samples of spruce, fir, and pine, infested by wood boring and bark inhabiting insects, were tested. All were negative for either form of the pinewood nematode.

There is no evidence to justify the existance of the pinewood nematode in the Maritimes as an organism of biologically significant importance to forest health (i.e., a tree killer). However, the consequences of its presence are economically significant if it affects our ability to export forest products because of plant quarantine-related regulations in other countries.

FOREST PEST ASSESSMENTS IN PLANTATIONS

In 1989, the Forest Insect and Disease Survey, two provincial agencies, an educational institution, and seven companies assessed pest conditions on over 35,000 trees in more than 900 plantations in New Brunswick and Nova Scotia. The increasing importance of planted trees in forest management resulted in the initiation of an annual plantation assessment program in 1982. The lessons learned from agriculture and from experience with large-scale forest plantings suggest that tracts of even-aged, single species forests will bring with them special pest problems. Previously insignificant pests may take on new importance and many of the well-known pests may change their habits in the new environment. Among these are the spruce bud moth, Sirococcus shoot blight, Armillaria root rot, needle rust on jack pine, and the seedling debarking weevil, which are described in some detail in other chapters of this report. As our knowledge of pest outbreaks in plantations accumulates, our methods of establishing and tending them must incorporate ways to offset the effects of such pests, if we wish to avoid or minimize losses.

The realization of the importance of forest pests to the future wood supply in New Brunswick resulted, in 1985, in the first large-scale joint plantation survey between the provincial Department of Natural Resources & Energy and the Forest Insect and Disease Survey of Forestry Canada - Maritimes Region to assess the general state of health of plantations and of silviculturally-treated (thinned) areas. There were large-scale joint surveys conducted in response to crisis situations in the past, such as the Scleroderris survey in 1979, in the wake of the discovery of the European race of that disease in the Province. The survey in 1985 was conducted as a pilot project in anticipation of regular, continuing surveys in future years. In 1986, the Department of Natural Resources and the Forest Insect and Disease Survey were joined by two of New Brunswick's larger forest companies, J.D. Irving Ltd.(JDI), and Fraser Inc.(Fras), in carrying out extensive pest assessment surveys in plantations. To ensure uniformity and standardization, both classroom and field instruction courses were conducted in advance of the actual field work. The surveys were expanded in 1987 and Consolidated Bathurst Inc. (CBI) and NBIP Forest Products Inc. (NBIP) from New Brunswick, and the Nova Scotia Department of Lands and Forests (NSLF), Bowater-Mersey Ltd. (B-M), and Stora Forest Industries Ltd. (Stora) joined this cooperative undertaking. In 1988, the plantation assessment surveys became truly regional for the first time with the involvement of the Prince Edward Island Dept. of Energy and Forestry. Canadian Pacific Forest Products Ltd-Miramichi Division (CPFP) in New Brunswick also participated for the first time.

In 1989, the Maritimes Forest Ranger School (MFRS) incorporated the FIDS plantation pest assessment survey into their curriculum. After a training session, with assistance from FIDS personnel, all students participated in assessing plantations in the UNB woodlot.

In 1989, plantations were assessed using two different methods. Assessment for federal and provincial agencies, and for most companies, in-

Table 14. Summary of plantation assessments by tree species and organization conducting assesments in the resource management regions of New Brunswick in 1989

Region	Tree species	Total plantations assessed	Organization						
			DNR	Fras	JDI	MFRS	CBI	Forcan	CPFP
1	Jack pine	10	8	1	-	-	1	-	-
	Balsam fir	1	1	-	-	-	-	-	-
	Black spruce	35	16	11	-	-	8	-	-
	White spruce	3	-	2	-	-	1	-	-
	Mixed Spruce	1	-	-	-	-	1	-	-
	Larch	2	1	1	-	-	-	-	-
Total for Region		52	26	15	0	0	11	0	0
2	Jack pine	6	6	-	-	-	-	-	-
	White pine	1	1	-	-	-	-	-	-
	Black spruce	10	8	1	-	-	-	1	-
	Mixed species	3	3	-	-	-	-	-	-
Total for Region		20	18	1	0	0	0	1	0
3	Jack pine	17	17	-	-	-	-	-	-
	Black spruce	11	11	-	-	-	-	-	-
	Spruce (unspec.)	4	4	-	-	-	-	-	-
	Mixed species	1	1	-	-	-	-	-	-
Total for Region		33	33	0	0	0	0	0	0
4	Jack pine	22	9	-	-	10	-	3	-
	Red pine	9	1	-	-	8	-	-	-
	White pine	2	-	-	-	2	-	-	-
	Black spruce	21	14	-	-	6	-	1	-
	Red spruce	1	-	-	-	-	-	-	1
	White spruce	2	2	-	-	-	-	-	-
	Mixed spruce	1	1	-	-	-	-	-	-
	Mixed species	4	4	-	-	-	-	-	-
	Larch	2	-	-	-	2	-	-	-
Total for Region		64	31	0	0	28	0	4	1
5	Jack pine	2	-	1	1	-	-	-	-
	Black spruce	72	4	48	20	-	-	-	-
	Norway spruce	1	-	-	1	-	-	-	-
	White spruce	24	2	10	12	-	-	-	-
	Mixed spruce	1	1	-	-	-	-	-	-
	Larch	5	-	5	-	-	-	-	-
Total for Region		105	7	0	64	34	0	0	0
Total for New Brunswick		274	115	80	34	28	11	5	1

Table 15. Summary of plantation assessments by tree species and organization conducting field work in the resource management regions of Nova Scotia in 1989

Region	Tree species	Total plantations assessed	Organization			
			Scott	NSLF	STORA	FORCAN
Cape Breton	Black spruce	5	-	-	5	-
	Red spruce	2	-	-	2	-
	White spruce	1	-	-	-	1
	Mixed spruce	1	-	-	1	-
Total for Region		9	0	0	8	1
Eastern	Jack pine	21	21	-	-	-
	Red pine	93	92	-	-	1
	White pine	28	28	-	-	-
	Black spruce	29	20	2	6	1
	Norway spruce	22	22	-	-	-
	Red spruce	5	3	-	2	-
	White spruce	59	58	1	-	-
	Mixed spruce	3	-	-	3	-
	Mixed species	1	-	-	1	-
Total for Region		261	244	3	12	2
N. Central	Jack pine	39	39	-	-	-
	Red pine	59	59	-	-	-
	White pine	4	4	-	-	-
	Black spruce	60	58	1	-	1
	Norway spruce	18	18	-	-	-
	Red spruce	39	38	1	-	-
	White spruce	32	32	-	-	-
	Mixed spruce	1	-	1	-	-
	Larch	4	4	-	-	-
Total for Region		256	252	3	0	1
S. Central	Jack pine	22	21	-	-	1
	Red pine	46	44	1	-	1
	White pine	5	4	1	-	-
	Black spruce	12	11	1	-	-
	Norway spruce	14	13	-	-	1
	Red spruce	3	3	-	-	-
	White spruce	12	11	1	-	-
	Larch	11	11	-	-	-
Total for Region		125	118	4	0	3
S. Shore	Red pine	3	-	3	-	-
	Mixed pine	1	-	1	-	-
	Norway spruce	2	-	2	-	-
Total for Region		6	0	6	0	0
Valley	Jack pine	1	-	1	-	-
	Black spruce	1	-	1	-	-
	Red spruce	5	-	5	-	-
Total for Region		7	0	7	0	0
Western	Red pine	5	-	5	-	-
	Red spruce	3	-	3	-	-
Total for Region		8	0	8	0	0
Total for Nova Scotia		671	614	30	20	7

Table 16. Summary of thinned areas assessed by DNR personnel in the resource management regions of New Brunswick in 1989

Stand composition	Total assessed	Thinned areas by region				
		1	2	3	4	5
Balsam fir	3	-	2	-	1	-
Black spruce	4	-	3	-	1	-
Mixed softwood	6	-	3	-	2	1
Mixed hardwood	1	-	-	-	1	-
Total	14	0	8	0	5	1

Table 17. The condition of trees in plantations in New Brunswick and Nova Scotia in 1989

Province	Species	Tree Condition (%)			
		Healthy	Fair	Poor	Dead
N.B.	Pine	93.3	4.3	1.7	0.7
	Spruce	90.9	6.2	1.1	1.8
	Other	85.9	10.2	3.2	0.7
	Average	90.9	6.9	2.0	1.1
N.S.*	Pine	88.9	5.7	2.0	3.4
	Spruce	92.7	4.4	1.4	1.5
	Other	84.0	6.0	10.0	0.0
	Average	91.6	4.8	1.7	1.9

*Does not include assessments conducted by Scott Worldwide Inc.

Table 18. Plantations with incidence of moderate or severe damage in the Maritimes in 1989

Province	Species	Number of plantations		
		Assessed	With damage	
			Mod.	Sev.
N.B.	Pine	69	18	9
	Spruce	187	33	75
	Other	18	5	9
	Total	274	56	93
N.S.*	Pine	14	6	4
	Spruce	42	10	7
	Other	1	0	0
	Total	157	16	11

*Does not include assessments conducted by Scott Worldwide Inc.

Table 19. Problems assessed as moderate or severe during plantation pest assessment surveys in the resource management regions of New Brunswick in 1989

	Number of plantations by region														
	Pine					Spruce					Other				
Problem	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Animal	1	-	2	9	-	9	1	1	3	24	-	1	-	3	1
Ant	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Aphid	1	-	-	1	1	-	-	-	-	4	-	-	-	-	3
Armillaria root rot	-	-	2	2	-	1	1	1	1	7	-	-	-	-	-
Bud midge	-	-	-	-	-	1	-	-	1	39	-	-	-	-	-
Budworm	-	-	1	-	-	2	-	-	-	20	1	-	-	-	-
Budmoth(s)	-	-	-	-	-	3	-	-	-	6	-	-	-	-	-
Competition															
- Hardwood	-	-	3	-	-	5	-	-	3	19	1	-	-	-	-
- Softwood	-	-	-	-	-	12	1	1	-	39	1	-	-	-	4
- Herbaceous	1	-	-	-	1	1	-	-	-	5	-	-	-	-	-
- Unspec.	-	-	-	3	-	1	-	-	1	2	-	-	-	-	-
Eastern spruce gall adelgid	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Frost	-	-	-	1	-	3	-	1	-	18	-	-	-	-	-
Gall adelgid(s)	-	-	-	-	-	1	2	-	2	-	-	-	-	-	-
Globose gall rust	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Jack pine aphid	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Mechanical	-	-	-	1	-	5	1	1	3	7	-	-	-	-	2
Needle rust	3	-	-	5	-	-	-	1	1	1	-	-	-	-	-
Northern pitch twig moth	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-
Planting	-	-	-	6	-	2	2	1	4	6	-	2	-	-	-
Root collar weevil	-	-	-	2	1	-	-	2	-	-	-	-	-	-	-
Sawfly	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Snow	-	1	1	4	-	-	-	1	-	-	-	-	-	-	-
Spruce cone gall midge	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Weather	1	1	1	-	-	1	-	-	-	-	-	-	-	1	-
Weevil (unspec.)	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-
White pine weevil	1	1	3	2	-	-	1	-	6	-	-	1	-	-	-
Winter drying	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Miscellaneous	4	1	2	10	1	7	-	-	7	38	-	4	-	8	3

cluded detailed examination of 50 trees in each plantation. Ten subplots, of five trees each, were selected along a pre-determined line of travel. The distance between subplots varied according to the size of the plantation to provide for uniform coverage. The level of damage on each tree-part by each pest found was recorded.

To test the feasibility and reliability of combining pest surveys with other types of plantation assessment, a pilot study was conducted in cooperation with Scott Worldwide Inc. in Nova Scotia. Plantations established between 1966 and 1981 were assessed by the company to obtain a variety of silvicultural parameters. In addition to these, a number of specific pest conditions were noted on up to four trees on each subplot in each plantation and observations recorded on field data collectors. There were two subplots per hectare (one subplot/acre). Although the results are not comparable in all respects, the surveys satisfy the

Table 20. Problems assessed as moderate or severe during plantation pest assessment surveys in the resource management regions of Nova Scotia in 1989

Problem	Number of plantations by region													
	Pine							Spruce						
	W	SS	V	NC	SC	E	CB	W	SS	V	NC	SC	E	CB
Animal	2	-	-	-	2	-	-	-	-	-	-	2	2	-
Armillaria root rot	-	-	-	-	-	1	-	-	-	-	-	-	6	2
Aphid	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Competition - herbaceous	-	-	-	-	-	-	-	-	-	1	-	-	1	-
Eastern spruce gall adelgid	-	-	-	-	-	-	-	-	-	-	-	1	-	-
European pine shoot moth	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Frost	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Mechanical	1	-		-	-	-	-	-	-	-	-	-	-	-
Needle rust	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Northern pitch twig moth	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Planting	-	-	-	-	-	-	-	-	-	1	-	-	4	1
Snow	-	-	1	-	2	-	-	-	-	-	-	-	-	1
Spruce bud midge	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Spider mite	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Weather	-	-	-	-	-	-	-	1	-	-	-	-	-	-
White pine weevil	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Wind	-	-	-	-	-	-	-	-	-	-	-	-	2	1
Winter drying	-	-	-	-	-	-	-	1	-	-	-	-	1	-
Miscellaneous	2	-	-	-	1	-	-	-	-	2	-	2	9	1

W = Western; SS = South Shore; V = Valley; NC = North Central; SC = South Central; E = Eastern; CB = Cape Breton

Table 21. Problems observed during plantation pest assessment surveys by Scott Worldwide Inc. in Nova Scotia in 1989.

Problem	Number of plantations							
	Pine			Spruce				Larch
	jP	rP	wP	bS	nS	rS	wS	tL
Armillaria root rot	1	4	7	1	1	-	3	2
European pine shoot moth	8	29	2	-	-	-	-	-
Frost	-	1	1	-	-	-	-	-
Shoot moth	-	-	-	-	1	-	1	-
Sirococcus shoot blight	-	16	-	-	-	-	-	-
Weevil	11	18	5	-	4	-	-	-
Other	73	127	35	16	21	6	8	14
Unknown	28	37	9	20	2	21	3	4

jP = jack pine; rP = red pine; wP = white pine; bS = black spruce; nS = norway spruce; rS = red spruce; wS = white spruce; tL = tamarack.

basic objective, the detection of pest problems and the identification of plantations in which pest control measures should be contemplated. Some pooling of information was possible and is as follows.

Field assessments were carried out mostly by staff of the various organizations. Identification of samples and summarizing were done by the Forest Insect and Disease Survey. Analysis of data is in progress and details will be reported at a later date.

In 1989, there were 908 plantations assessed by the various organizations, 248 in New Brunswick (Table 14), 671 in Nova Scotia (Table 15) (57 of these by the regular method and 614 by the "Scott's method"), and three in Prince Edward Island. Forty of the plantations were assessed twice during the summer. DNR also assessed 14 thinned areas (Table 16). Over 35,000 trees were examined in the course of the surveys.

A few brief comments on some of the results follow. Detailed information will be presented elsewhere (readers should be aware of the differences in the number of plantations assessed in the three provinces when looking at percentage figures). The comments are based on plantations assessed by the "regular" method only.

1. Over 90% of the trees assessed in New Brunswick and Nova Scotia were classified as healthy (Table 17).

2. Even though most trees were classified as healthy, there were at least some trees with severe damage in 34% of the plantations assessed in New Brunswick and 19% in Nova Scotia (Table 18).

3. There was a significant difference, on a regional basis, between spruce and pine plantations, regarding the occurrence of severely damaged trees. While 36% of spruce plantations had at least some severely damaged trees only 16% of pine plantations were so affected.

Table 19 lists the various plantation problems encountered at severe or moderate levels in New Brunswick; Table 20 in Nova Scotia. Table 21 lists the frequency of the specific pest problems encountered by Scott Worldwide Inc. No serious pest problems were encountered in the three plantations assessed in Prince Edward Island.

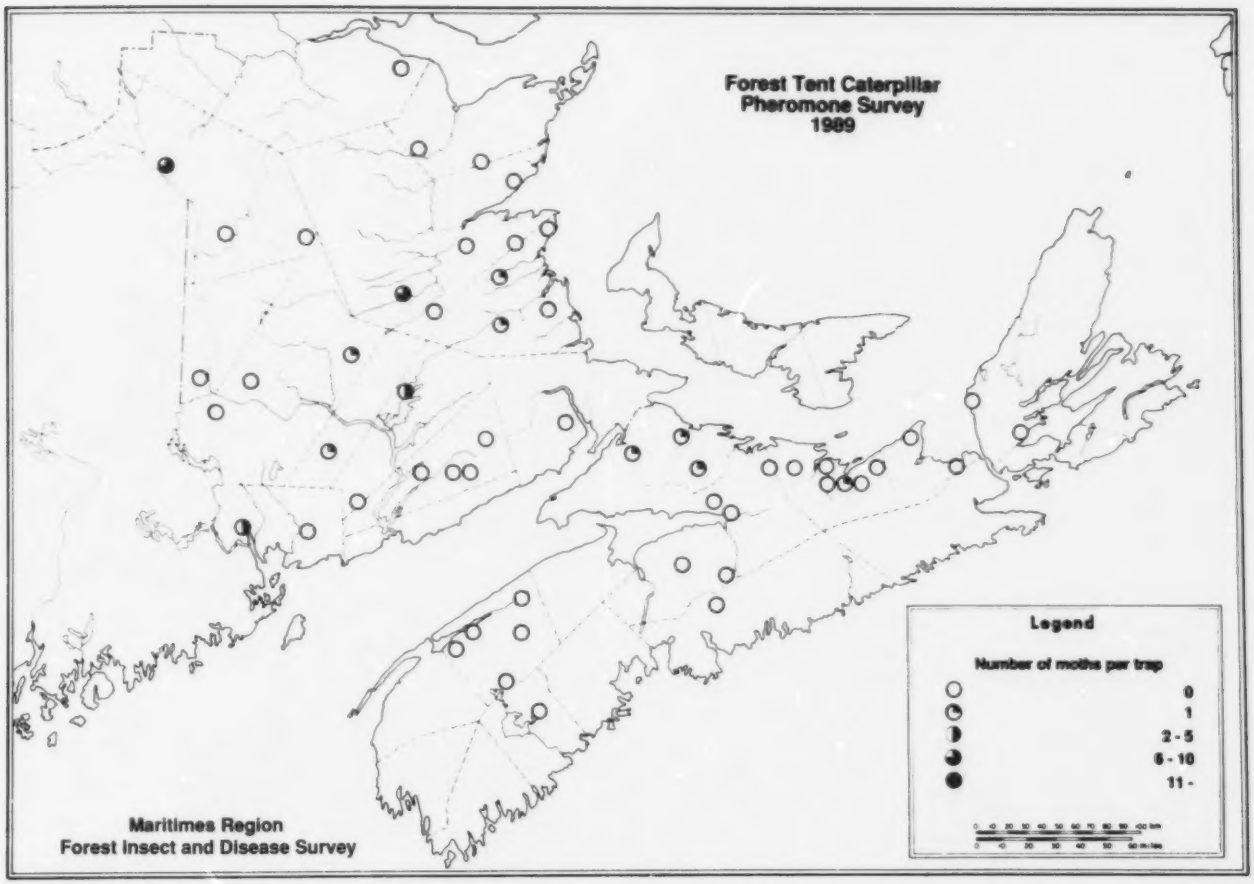


Figure 7.

PHEROMONE TRAPPING SURVEYS

Pheromones are chemical substances released by insects to communicate with another insect of the same species. In the case of sex pheromones, the female attracts males for the purpose of mating. Other forms of chemical communication include host attractants and aggregation pheromones. Collectively, these are called "semiochemicals". Researchers take advantage of these communication systems to detect, monitor, and predict populations of insects by luring the target pest into traps and counting the moths caught.

In the Maritimes, the Forest Insect and Disease Survey has been using pheromones as survey tools since 1971, when traps were first used in detection surveys for the gypsy moth. The effort has gradually increased since then and, in 1988, there were 11 insects for which pheromones were used in some manner. New lures are often tested in cooperation with researchers. If proven reliable in attracting the target insect, a period of calibration follows, which "gives meaning" to the numbers caught by a specific trap. Although much of the trapping and associated observations are carried out by our own personnel, considerable cooperation is forthcoming from provincial and industrial personnel and from other groups within Forestry Canada. Their assistance and the cooperation of researchers is acknowledged.

In 1989, pheromones or attractants were used for a number of insects. Comments on each follow:

Spruce budworm - As part of an inter-regional and international testing program to determine the

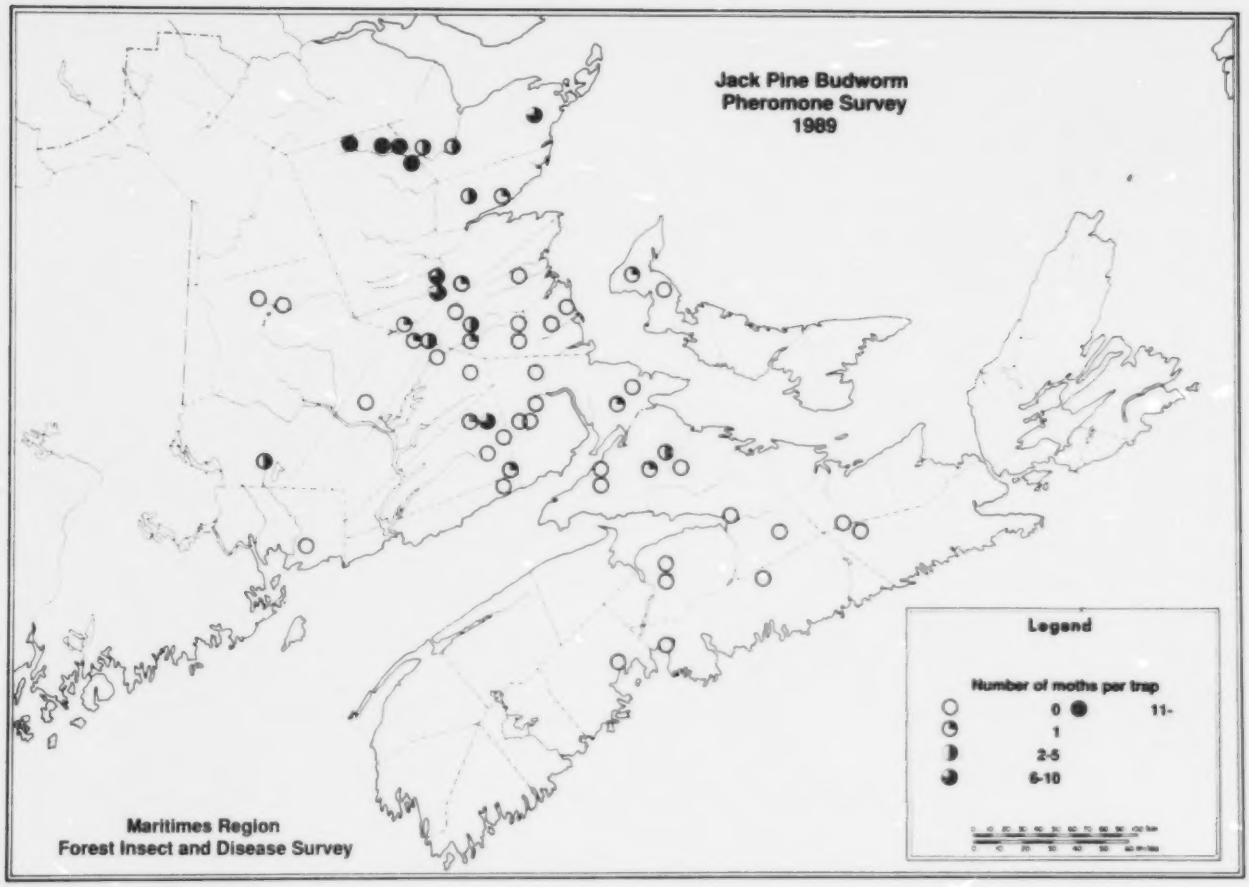


Figure 8.

reliability of traps and pheromones in monitoring annual population changes of the spruce budworm, a system was tested at 13 locations in the Maritimes in 1989. Cooperating in the program were J.D. Irving Ltd. (3 locations), and the regional Forest Insect and Disease Survey (10 locations).

Multipher® traps baited with Biolure® were deployed in clusters of three at each location in 1989. Adult males captured by the traps were counted at the end of the flight period, defoliation levels on the sample trees were determined, and L2 counts, an indicator of next year's expected population levels, were obtained. This information becomes part of the common data base to be analyzed for relationships before the system can become an operational tool. Further research will be necessary before resuming large-scale testing, conducted from 1985 to 1988.

Forest tent caterpillar - There was an increase in trap captures in 1989 from the very low levels of the previous three years (Fig. 7). While the numbers caught do not indicate widespread defoliation in 1990, the increasing trend may be important. The change in catch success and the number of traps employed during the last six years follows:

1984 - 60% positive (158 traps)
1985 - 40% positive (98 traps)
1986 - 12% positive (78 traps)
1987 - 1% positive (76 traps)
1988 - 7% positive (59 traps)
1989 - 23% positive (52 traps)

This increase comes 10 years after the initiation of the last major outbreak in Carleton County, New Brunswick; in the Maritimes, the forest tent caterpillar has been found to occur in roughly 10-year

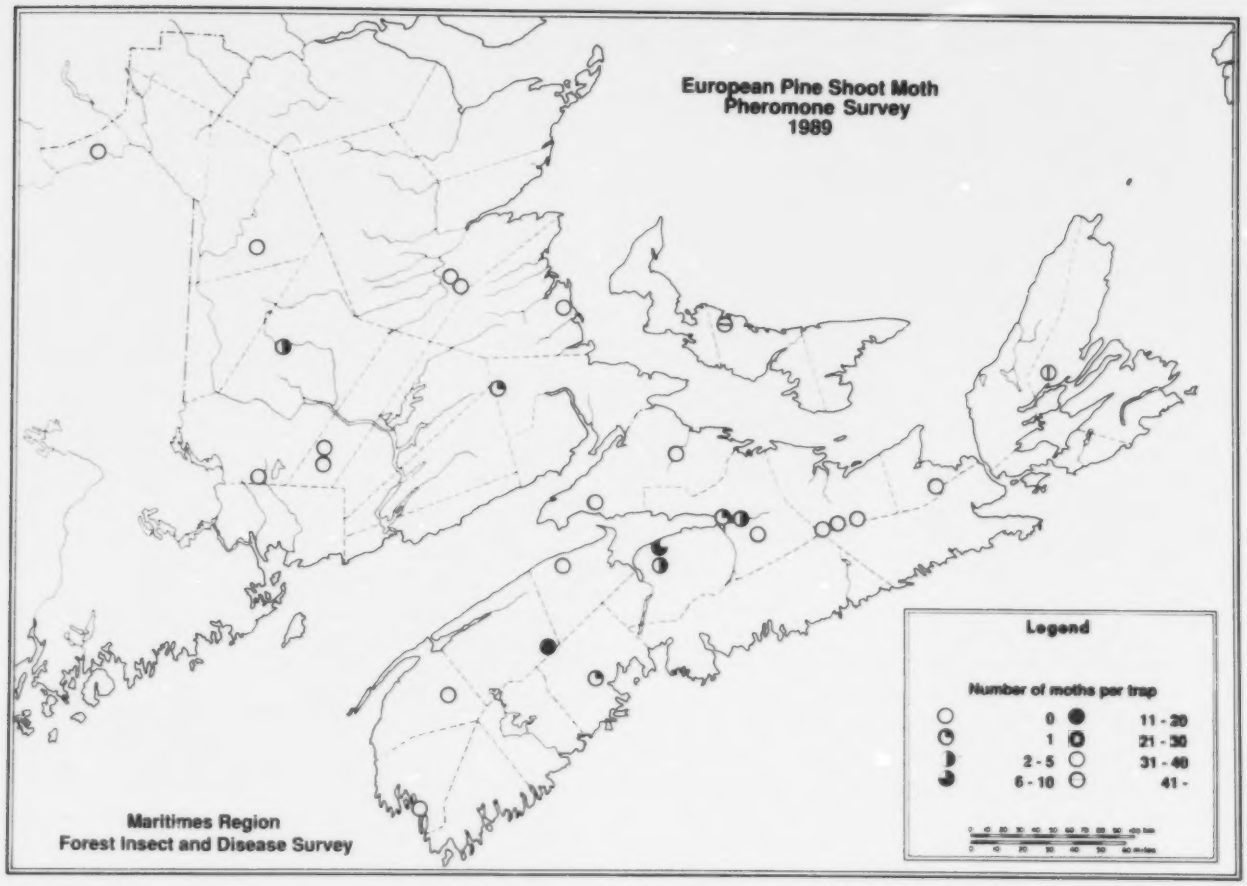


Figure 9.

cycles. The 1989 catches are also noteworthy in that two of the eight positive traps in New Brunswick had numbers reminiscent of the number of moths trapped in some outbreak areas during 1984. The increase in catch numbers in pheromone traps is paralleled by increases in catches at three New Brunswick light traps (Charlotte, Northumberland and Restigouche Counties) where a three-year increasing trend is now apparent, with the greatest increase in 1989.

The number of traps employed in 1990 will be increased, according to the pheromone-monitoring plan of FIDS-Maritimes, to allow for a more accurate description and prediction of a new outbreak, should it develop. Also, as a consequence of the 1989 results, forest tent caterpillar egg mass surveys, an accurate method of predicting population levels for the coming year, will be reinstated.

As the time approaches for another forest tent caterpillar outbreak in the Maritimes, the prediction and monitoring system of pheromone traps will receive its first test of its ability to accurately predict the damage and nuisance caused by this destructive pest of aspen, birch, sugar maple, and others.

Jack pine budworm - trap captures were again low in most Maritime locations, except for a group of traps in north-central New Brunswick, spread from Popple Depot to Heath Steele in Northumberland County, where higher numbers were recorded (Fig. 8). The trapping results were consistent with a lack of observations of larvae or defoliation. The only area where larvae and some defoliation (8% of shoots) were detected, was in the vicinity of the higher trap captures. The changes in the percent of positive locations and the

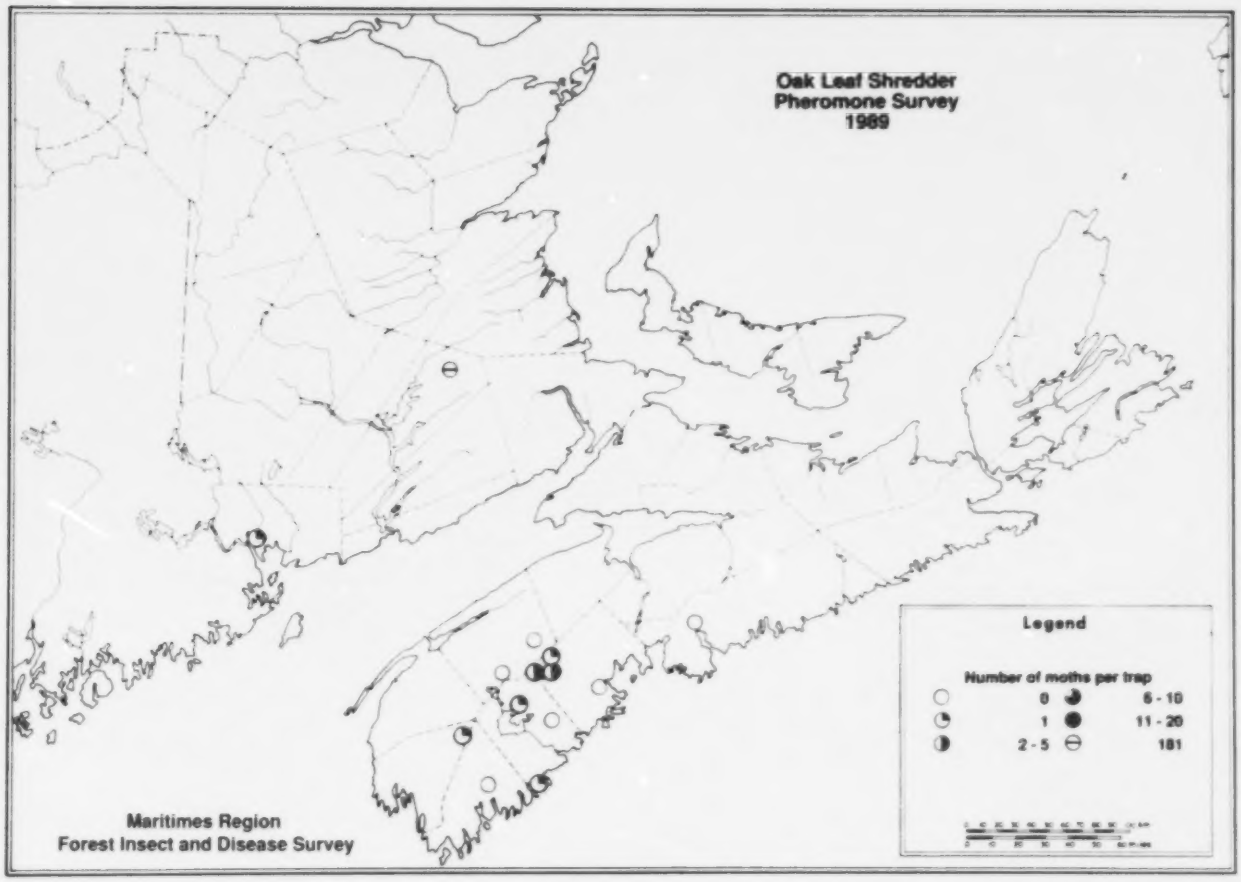


Figure 10.

number of trap locations over the past six years follow:

1984 - 72% positive (67 traps)
1985 - 84% positive (64 traps)
1986 - 60% positive (64 traps)
1987 - 49% positive (53 traps)
1988 - 35% positive (52 traps)
1989 - 43% positive (58 traps)

These results continue to be encouraging in terms of the ability of jack pine budworm pheromone traps to predict population increases. Surveillance will be increased in the areas of higher trap captures.

European pine shoot moth - Trap captures remain low throughout New Brunswick (Fig. 9). In Nova Scotia, slight increases in trap capture (44% report positive) occurred at several locations in 1989, which coincide with other field reports of the insect "appearing to be more common" although damage levels are light. At Hastings, Annapolis County, a larger number of moths were caught (18.5/trap) and damage was moderate to severe with 70% of 1 m trees being affected. A large number of moths was also trapped at Middle River, Victoria County, on Cape Breton Island, where no moths were encountered in 1988. In Prince Edward Island, at North Granville, Queens County, where an increase in trapped moths was found during 1988, a further large increase occurred in 1989 (45 moths/trap) and severe damage was found on 1-2 m red pine in the district (up to 100% of trees affected).

Pine shoot moth outbreaks are more location-specific than for many pests as population levels

depend to a great extent on the height of trees on the site, with trees over 3 m generally escaping damage. Thus, two adjacent plantations with a one-metre height difference often harbor completely different populations. This necessitates periodic changing of trapping locations as trees grow, making comparison between years more difficult. Our evidence suggests that pheromone trap monitoring for European pine shoot moth is especially useful as a detection and early warning device when established in young plantations less than 1 m in height.

Oak leaf shredder - Trap catches were reduced at all Nova Scotia locations (Fig. 10). As populations were already considered to be below the threshold of significant damage, these results confirm that the insect continues to play only a minor role in the shredder/leafroller species mix there. In New Brunswick, at Cranberry Lake, Queens County, populations increased greatly to 181 moths/trap in 1989 from 37 moths/trap in 1988, indicating that this pest continues to be of major importance there.

Oak leafroller - In 1989, a new pheromone lure, developed by G. Grant of the Forest Pest Management Institute of Forestry Canada, was first tested on a Maritimes-wide basis. Traps were placed at the same locations as for the oak leaf shredder, to help investigate the species mix. Large numbers of moths were caught at all locations, consistent with the continuing severe damage caused by this pest. Detailed trapping results are not published here, pending a better understanding of what the number of moths caught means in terms of larval populations or damage. Many of the sticky traps used were completely covered with moths, or "saturated". Without being able to measure the upper limits, it is not possible to determine whether the lures are super-sensitive or populations are exceptionally high. Further testing of this promising trapping system will continue in 1990.

Spruce budmoths - Lures for the spruce budmoth (*Zeiraphera canadensis*) and for the purplestriped shootworm (*Z. unfortunana*) have been tested for two years. Because of the need for further laboratory testing of one of the lures, no trapping was conducted for these two insects in 1989. It is anticipated that this work will resume in 1990.

Seedling debarking weevil - compounds which attract the seedling debarking weevil have been under development for use in ground traps since 1985, by the Forest Insect and Disease Survey and through contracts let to the Research and Productivity Council of New Brunswick. A lure is now available which has been tested in 1988 and 1989. Once calibrations are completed, the lure may provide a reliable survey tool for use in predicting hazard due to the weevil in potential plantation sites.

Gypsy moth - the pheromone trapping detection survey has been used in the Maritimes since 1971. The program is a multi-agency effort and is discussed in detail elsewhere in this report.

Spruce coneworm - a lure for the spruce coneworm, *Dioryctria reniculelloides*, was tested in the Maritimes for the second time in 1989. As spruce coneworm populations remain generally low throughout the region, a calibration of this trapping system is not yet possible, although the traps are useful for detection purposes. One moth was caught in 1989, at the Parkingdale Seed Orchard, Albert County, New Brunswick, out of 13 trapping locations in New Brunswick and 20 locations in Nova Scotia.

Fir coneworm - a lure for the fir coneworm, *Dioryctria abietivorella*, was tested on a limited basis in the Maritimes during 1989. No moths were caught. Future trials are planned in conjunction with assessments of Maritime seed orchard pests.

THE LIGHT TRAP MONITORING SYSTEM

Taking advantage of the fact that many insects are attracted to light, the Forest Insect and Disease Survey has been using light traps to monitor insect populations since shortly after the Second World War. The traps use a built-in light source to capture and kill insects, which are then identified and counted. The information is used in designing other types of surveys, predicting population build-ups, and in research.

The 16 light traps in the Maritimes Region listed below are maintained by federal forestry personnel, provincial government cooperators, National Parks personnel, industrial concerns or private individuals on behalf of the Forest Insect and Disease Survey; they operate from mid-April until late fall. Catches are collected daily and the material is submitted for identification on a weekly basis. After a period of experimentation during the early years, all traps and light sources were standardized in 1976 and trap locations remained the same except in a few unavoidable situations.

Light trap locations in the Maritimes Region in 1989 were as follows:

NEW BRUNSWICK

Acadia Forest Exp. Sta., Ripples, Sunbury County
Ashton Hill, Northumberland County
Canterbury, York County
Fundy National Park, Albert County
Mayfield, Charlotte County
Nash Creek, Restigouche County
Plaster Rock, Victoria County

NOVA SCOTIA

Big Intervale, Victoria County
Georgeville, Antigonish County
Kejimkujik National Park, Annapolis County
Lawrencetown, Annapolis County
Liverpool, Queens County
Londonderry, Colchester County

PRINCE EDWARD ISLAND

Breadalbane, Queens County
Howlan, Prince County
Kilmuir, Kings County

A new light trap was located in 1989 at Forestry Canada's Acadia Forest Experiment Station near Ripples, Sunbury County, N.B., to replace the light trap with the longest record of operation, at the old Maritimes Forest Research Centre on the University of New Brunswick campus in Fredericton, N.B. That trap was discontinued at the end of 1987 when the institution moved to new quarters.

The light trap at Nash Creek was moved from its previous site at Balmoral, Restigouche County. This move, also in 1989, was necessitated by the closing of the forestry cache at Balmoral at the end of the 1988 season.

OTHER INSECTS AND DISEASES

This table lists alphabetically, by common name, most insects and diseases encountered in the Maritimes in 1989 but not discussed in detail elsewhere in the report. Inclusion in the table does not imply that the organism is necessarily of lesser economic importance than those discussed in the text. It may be that an organism, e.g., larch sawfly, is at an ebb of biological activity and did not cause enough concern in 1989 to warrant detailed discussion. It may be that, although severe, an organism, e.g., poplar leafmining sawfly, was only of localized importance in 1989.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Alder flea beetle *Altica ambiens alni* Harr.	Alder	Region	Overall intensity increased in the Region, browning was moderate or severe in western New Brunswick, light to moderate elswhere; in Nova Scotia, light or moderate throughout, with scattered patches of severe browning in central and western parts; in Prince Edward Island, moderate or severe patches in all three counties.
Anthracnose of hardwoods *Discula quercina* (West.) Arx	Black ash White ash Beech	Region	In New Brunswick, present at varying intensities on beech and black ash at a few scattered locations; in Nova Scotia, an average of 62% of beech leaves were affected in Inverness and Victoria Counties (6 locations); in Prince Edward Island, light and moderate browning on white ash in Prince and Kings Counties.
Anthracnose of maple *Kabatiella apocrypta* (Ell. and Ev.) Arx	Red maple Sugar maple	Region	Leaf browning from trace to moderate throughout New Brunswick, the most serious foliage discoloration observed at Petit Pacquetville, Gloucester County, where 39% of the sugar maple leaves were affected; mostly trace to light levels of infection at scattered locations throughout Nova Scotia, except at Black Brook, Inverness Co., where 93% of sugar maple leaves turned brown; only one record of light infection on sugar maple in Prince Edward Island.
Ants	Conifers	Region	Not nearly as common in plantations in Prince Edward Island as in 1988. No reports from New Brunswick or Nova Scotia.
Ash yellows	Ash	Region	Not found in the Region to date. This disease is present in the United States and is of concern to plant quarantine officials.
Aspen leafrollers *Epinotia criddleana* (Kft.) *Pseudexentera oregonana* (Wlshm.) Darkheaded aspen leafroller *Anacampsis innocuella* (Zell.) Lightheaded aspen leafroller *Anacampsis niveopulvella* (Cham.) Spotted aspen leafroller *Pseudosciaphila duplex* (Wlshm.)	Trembling aspen	Region	Leafrolling remained at trace or light levels throughout the Region. Leafrolling at Aylesford East, Kings Co., Nova Scotia declined for the second consecutive year, to 9%, from 35%, in 1988.
Aspen webworm *Tetralopha aplastella* (Hist.)	Aspen	Region	Leafrolling at light levels at 4 locations in New Brunswick; trace at two locations in Nova Scotia. No reports from Prince Edward Island.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Atmospheric impurities	White pine	Region	No reports in 1989.
Bagworm *Thyridopteryx ephemeraeformis* Haw.	White pine	Region	Found at one location in Lunenburg County, N.S. No reports from New Brunswick or Prince Edward Island.
Balsam bark weevil *Pissodes dubius* Rand.	Balsam fir Red spruce	Region	Common on dead and dying balsam fir in New Brunswick (average of 6% of trees at five locations in five counties). Collected at one location from red spruce in Nova Scotia. No reports from Prince Edward Island.
Balsam fir bark beetle *Pityokteines sparsus* (Lec.)	Balsam fir	Region	Present throughout much of New Brunswick in weakened trees. Highest infestation at West Branch, Kent County (28% of trees infested). No reports from Nova Scotia or Prince Edward Island.
Balsam fir sawfly *Neodiprion abietis* (Harr.)	Balsam fir	Region	Few larvae at scattered locations throughout the region.
Balsam shootboring sawfly *Pleroneura brunneicornis* Roh.	Balsam fir	N.B. N.S.	Widespread but caused only light shoot damage in New Brunswick. Only three reports of light damage in Nova Scotia.
Beech bark disease *Nectria coccinea* var. *faginata* Lohm., Wats. & Ayers and Beech Scale *Cryptococcus fagisuga* Lind.	Beech	Region	Cankered trees are common throughout the Region. Average of cankered trees 80% in New Brunswick (8 locations), 79% in Nova Scotia (8 locations), and 87% in Prince Edward Island (4 locations).
Birch sawfly *Arge pectoralis* (Leach)	Speckled alder Wire birch	N.B. N.S.	Trace or light defoliation at a few scattered locations, except at Nashwaak River, York Co., New Brunswick, where speckled alder was moderately defoliated.
Birch leaf spot *Septoria betulina* Pass.	White birch	N.B. N.S.	Often occurs in close association with unexplained foliage discoloration of white birch along the Bay of Fndy; in New Brunswick, an average of 31% of leaves affected (13 locations; highest 81%); common in Nova Scotia, found in seven counties on the mainland and throughout Cape Breton Island, associated with foliage discoloration.
Black leaf blister *Taphrina dearnessii* Jenkins	Red maple	Region	Present at low levels in all three provinces.
Brown felt blight *Herpotrichia juniperi* (Duby) Petr.	White spruce	N.S.	Found at four scattered locations on white spruce dense regeneration. At Barrio Deadwater, Digby Co., 39% of lower foliage affected on a small clump of young trees.
Bruce spanworm *Operophtera bruceata* (Hist.)	Red maple Sugar maple Trembling aspen	Region	Single collections from Northumberland Co., New Brunswick and Pictou, Cumberland, and Queens Counties, Nova Scotia. No reports from Prince Edward Island.
Canker of larch *Potebniamyces coniferarum* (Hahn) Smerlis	Tamarack	Region	Found at two locations in New Brunswick and one location each in Nova Scotia and Prince Edward Island.
Cedar leafminers *Argyresthia aureoargentella* Brower *Argyresthia freyella* Wlshm.	Cedar	N.B. P.E.I.	Still present at Latimer Lake, St. John Co., New Brunswick, where 76% of the shoots were affected on 100% of the trees, populations low

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Argyresthia thuiella (Pack.) *Coleotechnites thujaella* (Kft.)			elsewhere. In Prince Edward Island, trees continued to deteriorate in the Muddy Creek, Miscouche, and Wellington areas of Prince Co.
Cherry blight	Choke cherry Pin cherry	Region	Present throughout most of Region, much more common in 1989 than 1988. Common in: Charlotte, Kent, Gloucester, and Restigouche Counties, New Brunswick; Inverness and Cape Breton Counties, Nova Scotia; and Queens Co., Prince Edward Island.
Cherry casebearer *Coleophora pruniella* Clem.	Pin cherry Trembling aspen	Region	At endemic levels in New Brunswick and Nova Scotia. In Prince Edward Island, leaf browning of trembling aspen moderate and severe in a 6 ha area at Lower Newtown, Queens Co., moderate in small aspen stands and hedgerows at Kilmuir and Commercial Cross, Kings Co., and on most trees at Orwell, Queens Co.
Deterioration of cedar	Cedar	N.B. P.E.I.	In New Brunswick, condition of trees improved in Charlotte and St. John Counties, except in the Latimer Lake area, St. John Co., where tree condition declined further. Damage by the cedar leafminer complex increased, however, the initial cause of the deterioration remains uncertain. In Prince Edward Island, tree deterioration continued in the Muddy Creek area of Prince Co., where some trees died, others had dead branches or tops.
Diplodia tip blight *Sphaeropsis sapinea* (Fr.) Dyko & Sutton	Red pine	N.S.	Trace shoot damage on 6% of young plantation trees in Queens County.
Drought and hardwood branch mortality	Hardwoods	Region	The severe branch mortality on ornamental and roadside hardwoods, reported in New Brunswick and Prince Edward Island in 1988, did not recur in 1989. The branches which died in spring 1988 were still present on the affected trees. Severely stressed trees either suffered further branch mortality or died. In Fredericton, York Co., N.B., twenty-seven large maples (diameter greater than 40 cm) in poor condition were removed along sidewalks as part of the City's sanitation effort.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Balsam fir Red spruce White spruce	Region	Few larvae at numerous locations throughout the Region.
Eastern dwarf mistletoe *Arceuthobium pusillum* Peck	Spruce	Region	Found at scattered locations in the Region, the highest number of brooms recorded at Doctor's Brook, Antigonish Co., and Dunvegan, Inverness Co., Nova Scotia, where 44% and 40% of trees had at least one broom each, respectively.
Eastern spruce gall adelgid *Adelges abietis* (L.)	Red spruce White spruce	Region	Present throughout Region, generally at trace to light infestation levels.
Eastern tent caterpillar *Malacosoma americanum* (F.)	Apple Cherry	Region	More common throughout the Region than in 1988, except in the northern counties of New Brunswick.
Elm leaf aphid *Tinocallis ulmifolii* (Monell)	Elm	N.B.	No reports in 1989.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Elm leaf beetle *Pyrrhalta luteola* (Mull.)	Elm	N.B.	Severe foliage browning in Fredericton, York Co., a dramatic increase from trace levels in 1988.
Elm leafminer *Fenusa ulmi* Sund.	English elm Rock elm	Region	In New Brunswick, severe browning on exotic elms at Sackville, Dorchester, and Moncton, Westmorland Co., and Riverview, Albert Co. In Nova Scotia and Prince Edward Island, moderate and severe browning of exotic elms at most places where hosts are present.
European pine sawfly *Neodiprion sertifer* (Geoff.)	Scots pine Pine	Region	Less common in Nova Scotia than in 1988, with moderate defoliation on Scots pine at Little Bras d'Or, Cape Breton Co. No reports from New Brunswick or Prince Edward Island.
European pine shoot moth *Rhyacionia bouliana* (D. & S.)	Red pine	Region	In New Brunswick, recorded only in a plantation at Penobsquis, Kings Co., where shoot damage was widspread. In Nova Scotia, light damage on 70% of 1-m high trees in a plantation west of Hastings, Annapolis Co., elsewhere trace shoot damage common. In Prince Edward Island, severe shoot damage, with nearly all shoots on some trees infested, at North and South Granville; moderate damage (37%) on nearly all trees at Auburn Woodlot; light damage on 80% of trees in a 1 -m high plantation between Darnley and Irishtown, Queens Co.
European spruce sawfly *Gilpinia hercyniae* (Htg.)	Spruce	Region	Populations remained low throughout the Region.
Fall cankerworm *Alsophila pometaria* (Harr.)	Hardwoods	Region	Populations remained low throughout the Region. Trace to light defoliation on ornamentals in Truro, Colchester Co., Nova Scotia.
Fall webworm *Hyphantria cunea* (Dru.)	Deciduous	Region	Nests much more common in all three provinces than in 1988, especially in southeastern Kent Co., New Brunswick, in the central and western counties in Nova Scotia, and throughout Prince Edward Island.
Flat leaf tier *Psilocorsis* sp.	Hardwoods	Region	Trace or light amounts of leaf tying at several locations in New Brunswick and Nova Scotia, except in some areas of Queens County, Nova Scotia, where moderate damage occurred on red oak. No reports from Prince Edward Island.
Forest tent caterpillar *Malacosoma disstria* Hbn.	Hardwoods	Region	Populations very low throughout the Region. Light defoliation occurred in Antigonish Co., Nova Scotia and a few larvae were collected at other scattered locations. Not observed in Prince Edward Island. Light-trap catches and pheromone surveys indicate a population increase may occur in 1990, especially in New Brunswick.
Foureyed spruce bark beetle *Polygraphus rufipennis* (Kby.)	Black spruce Red spruce White spruce	Region	Found at 9 scattered locations in New Brunswick with an average of 7% trees attacked. Few insects collected at 2 locations in Colchester and Kings Counties, Nova Scotia. Not recorded in Prince Edward Island.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Frost damage	Conifers Hardwoods	N.B. N.S.	Widespread damage throughout northern New Brunswick on balsam fir and, to a lesser extent, white spruce; shoot damage severe on balsam fir at South Tracadie River and Teagues Lake Road, Gloucester Co. In Nova Scotia, an average of 7% of shoots damaged at 36 locations in 9 counties, the highest damage, 27% of new shoots of balsam fir killed at Cape Blomidon, Kings Co.
Globose gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jack pine Mugho pine Scots pine	Region	Scattered in plantations and on ornamentals throughout the Region. Widespread in New Brunswick in jack pine plantations, and in natural stands, common on ornamental species; 56% of trees infected at Le Castor, Kouchibouguac National Park. In Nova Scotia, highest incidence recorded at West Leicester, Cumberland Co., with 8% of trees infected in a Scots pine plantation.
Greenheaded spruce sawfly *Pikonema dimmockii* (Cress.)	Spruce	Region	Population low throughout the Region.
Greenstriped mapleworm *Dryocampa rubicunda rubicunda* (F.)	Red maple	Region	Population remained low in New Brunswick with only trace defoliation on a few trees in Westmorland Co.; light defoliation in an area of Lunenburg Co., Nova Scotia; no reports from Prince Edward Island.
Hail damage	Conifers Hardwoods	Region	No reports in 1989.
Hypoxylon canker *Hypoxylon mammatum* (Wahl.) Mill.	Trembling aspen	Region	Present throughout the Region: in New Brunswick, an average of 13% of trees infected at 23 locations in 10 counties; in Prince Edward Island, an average of 8% of trees infected at 3 locations. No comparable figure available from Nova Scotia, but mortality levels generally low.
Ink spot of aspen *Ciborinia whetzelii* (Seaver) Seaver	Trembling aspen Poplar	N.B.	Found at a few scattered locations at trace or light infection levels.
Jack pine budworm *Choristoneura pinus pinus* Free.	Jack pine	Region	No significant defoliation occurred in the Region in1989. However, catches in pheromone traps increased considerably from those of previous years in northeastern New Brunswick, indicating a population increase in the area.
Larch needleworm *Zeiraphera improbana* (Wlk.)	Tamarack	N.S.	Trace defoliation in an area of Inverness County.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Japanese larch Tamarack	Region	Defoliation severe and moderate on experimental Japanese larch at MacDonald's Corner, Queens Co., New Brunswick; trace defoliation occurred in Westmorland and York Counties. In Prince Edward Island, defoliation declined to trace at St. Lawrence and near Bloomfield, Prince Co., where it was severe on scattered trees in 1988. No reports from Nova Scotia.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	Region	At endemic levels throughout.
Leaf and twig blight of aspen *Venturia macularis* (Fr.) Muell. & Arx	Largetooth aspen	Region	Shoot damage similar in intensity but less common than in 1988: In New Brunswick,

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
	Trembling aspen Hybrid poplar		averaged 10% (18 locations, highest 20%), in Nova Scotia, 4% (10 locations, highest 24%), and in Prince Edward Island, shoot damage was light.
Leaf blister *Taphrina carnea* Johanson	Yellow birch	Region	Present at scattered locations throughout New Brunswick, with average of 18% of leaves infected (17 locations). In Nova Scotia, infection averaged 19% (12 locations). Found at one location in Prince Edward Island, where 12% of leaves were infected.
Leaf blotch of horse-chestnut *Guignardia aesculi* (Peck) V.B. Stew.	Horsechestnut	Region	Found wherever host occurs throughout the Region, but intensity of browning was reduced from that observed in 1988: in New Brunswick, leaf browning was trace (from light in 1988); in Nova Scotia, light and moderate with only scattered trees with severe damage (from generally severe in 1988); and in Prince Edward Island, leaf browning was only trace or light.
Leaf spot of poplar *Drepanopeziza tremulae* Rimpau	Largetooth aspen Trembling aspen	Region	Foliage browning at varying intensity in a few scattered areas in all three provinces, moderate or severe in Carleton Co., New Brunswick, light or moderate in Nova Scotia, and from light to severe in Prince Edward Island.
Lesser aspen webworm *Meroptera pravella* (Grt.)	Trembling aspen	Region	No reports in 1989.
Lesser maple spanworm *Itame pustularia* (Gn.)	Red maple	Region	Few larvae throughout Nova Scotia and Prince Edward Island. No reports from New Brunswick.
Maple leafroller *Sparganothis acerivorana* MacK.	Red maple Sugar maple	Region	Leaf rolling was light in New Brunswick (31 locations in 9 counties), the highest being 21% of leaves affected on 90% of trees at Cranberry Lake, Queens Co. Less than 5% of leaves rolled at two locations in Prince Edward Island. No reports from Nova Scotia.
Maple spindlegall mite *Vasates aceris-crumena* (Rly.)	Sugar maple	Region	Common on sugar maple foliage throughout the Region, affecting an average of 31% of leaves in New Brunswick, 34% in Nova Scotia, and 24% in Prince Edward Island. As much as 93% of the leaves were found infested in an area in northern New Brunswick, covering them with unsightly spindles and affecting the aesthetic appearance of shade trees.
Mites *Oligonychus milleri* (McGregor) *Oligonychus ununguis* (Jacobi)	Jack pine Red pine Balsam fir Red spruce	Region	No reports in 1989.
Mottled and discolored foliage	Conifers Hardwoods	Region	Various types of foliage discoloration, occurring at various intensity levels, and probably caused by a variety of undetermined factors, were observed in New Brunswick, on black spruce in Kent Co., and on red maple also in Kent Co.; on red pine in Yarmouth Co., on largetooth aspen in Annapolis, Hants, and Kings Counties, on tamarack in Inverness Co., on hemlock in Hants Co., on balsam fir in Lunenburg, Antigonish, and Halifax Counties, on white

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
			spruce in Antigonish and Colchester Counties and on red spruce in Annapolis County. No reports from Prince Edward Island.
Mountain ash sawfly *Pristiphora geniculata* (Htg.)	Mountain ash	Region	Few larvae found only at one location in each of Nova Scotia and Prince Edward Island. Not found in New Brunswick.
Needle casts			
Davisomycella ampla (Davis) Darker	Jack pine	Region	No reports in 1989.
Isthmiella faullii (Darker) Darker	Balsam fir	N.B. N.S.	Severe browning on scattered trees at Skin Gulch, Victoria Co., and trace at a location in Madawaska Co., New Brunswick; light in one area each in Cumberland and Inverness Counties, Nova Scotia.
Lirula macrospora (Hartig) Darker	Black spruce Red spruce White spruce	Region	Severe and moderate browning in black spruce plantations in Victoria Co., light on red spruce in Queens and Kings Counties, New Brunswick; light or trace browning in Nova Scotia, except at Two Mile Lake, Halifax County, where 31% of red spruce needles were affected; only a trace of needle browning observed at one location in Prince Edward Island.
Lirula nervata (Darker) Darker	Balsam fir	Region	Infection levels low at a few locations.
Phaeocryptopus gaeumannii (Rohde) Petr.	Douglas fir	N.B. N.S.	Severe on 1988 foliage in a 1-ha plantation near Tay Falls, York Co., New Brunswick. Infected 10% of old foliage of plantation trees at West Leicester, Cumberland Co., Nova Scotia.
Northern cedar bark beetle *Phloeosinus canadensis* Sw.	Cedar	N.B.	No red flags observed in areas of Carleton County in 1989 where they occurred in 1987 and, in reduced numbers, in 1988.
Northern pitch twig moth *Petrova albicapitana* (Busck)	Jack pine	Region	Widespread but at low populations in jack pine plantations and natural stands in New Brunswick, averaging 14% of trees infested at 8 locations. In Nova Scotia, 56% of jack pine trees affected at Battery Lake, Pictou County, light infestation in an area in Guysborough County. Present on a few jack pine branches at Goose River, Kings Co., Prince Edward Island.
Oblquebanded leafroller *Choristoneura rosaceana* (Harr.)	Beech Red maple Sugar maple Trembling aspen White birch Wire birch Yellow birch	Region	More common in New Brunswick than in recent years, causing light leaf rolling. Observed at a few scattered locations in Nova Scotia and Prince Edward Island, with only a few leaves rolled.
Ocean salt spray	Spruce	Region	Trace foliage browning on exposed coastal trees in Prince Edward Island National Park. No reports from New Brunswick and Nova Scotia.
Ocellate gall midge *Acericecis ocellaris* (O.S.)	Red maple Sugar maple	Region	Common throughout Region, affecting the appearance of heavily infested leaves.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Orangehumped mapleworm *Symmerista leucitys* Francl.	Beech	Region	Populations generally low, a few larvae found feeding on beech at two locations in Kejimkujik National Park, Queens Co., Nova Scotia. No reports from New Brunswick or Prince Edward Island.
Orange spruce needleminer *Coleotechnites piceaella* (Kft.)	Balsam fir Black spruce Red spruce	Region	Populations low but present at several locations in all three provinces, mining up to 8% of needles.
Pepper-and-salt moth *Biston betularia cognataria* (Gn.)	Yellow birch Tamarack	Region	Light defoliation of yellow birch in Fundy National Park, New Brunswick; present on scattered plantation tamarack trees in Prince Co., Prince Edward Island; no reports from Nova Scotia.
Pine bark adelgid *Pineus strobi* (Htg.)	Pine	Region	Present on 60% of branches of 30% of white pine at Kent Lake, Kent Co., New Brunswick; found on white pine at 10 scattered locations in Nova Scotia, averaging 20% on trees affected, highest count 61% of trees infested at Brooklyn Corner, Kings Co.; no reports from Prince Edward Island.
Pine engraver *Ips pini* (Say)	Jack pine	N.B.	Larvae present in root collar area of two recently killed jack pines in a 1975 plantation in Gloucester Co., New Brunswick.
Pinkstriped oakworm *Anisota virginiensis virginiensis* (Drury)	Red oak	Region	No reports in 1989.
Poplar flea beetle *Altica populi* Brown	Balsam poplar	N.B.	Severe foliage browning at Oromocto Lake, Sunbury Co., and Prince William, York Co. Elsewhere, very common in southern York County and in most of Charlotte County, causing light or moderate browning.
Poplar leaffolding sawfly *Phyllocolpa* sp.	Trembling aspen	Region	In New Brunswick, 23% of leaf edges folded on 92% of trees examined at 28 locations; highest at Rankin Brook, Kent Co., all trees were affected and 73% of leaves folded. In Nova Scotia, 8% of leaves folded on 57% of trees at 31 locations; highest at Mill Brook, Cape Breton Co., where 52% of leaves were affected. In Prince Edward Island, 36% of leaves were affected on 83% of trees at 15 locations; highest at North Enmore, Prince Co., with 85% of leaves folded.
Poplar leafmining sawfly *Messa populifoliella* (Town.)	Trembling aspen Balsam poplar	Region	In New Brunswick, populations much lower than in 1988 in Kings and Restigouche Counties; light mining of trembling aspen also in Northumberland County, and of balsam poplar in Victoria County. In Nova Scotia, trace browning of trembling aspen in Annapolis County. No reports from Prince Edward Island.
Poplar petiolegall moth *Ectoedemia populella* Busck	Trembling aspen	N.S. P.E.I.	In Nova Scotia, 55% of leaf-stems affected at Black River, Kings Co., elsewhere an average of 14% of leaves affected (8 locations). All petioles of all trees affected at Goose River, Kings Co., Prince Edward Island.
Porcupine damage	White birch Balsam fir Jack pine Red pine	N.B. N.S.	Damage common throughout New Brunswick and Nova Scotia. Most serious damage recorded (28% of trees) at Union Corner, Carleton Co., N.B., on white pine, and at

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
	White pine Black spruce Red spruce White spruce Tamarack		Ingramport, Halifax Co., N.S. on red pine.
Premature needle loss	Black spruce	N.B.	Premature needle loss of one-year-old needles in plantations was only 5% in 1989, compared to 52% in the spring of 1988. The cause of the condition remains unknown.
Rabbit damage	Black spruce White spruce	Region	A few scattered reports from central Nova Scotia. In Prince Edward Island, damage moderate on white spruce at the Brookvale Demonstration Woodlot, Queens Co., and light on black spruce at East Bideford, Kings County. No reports from New Brunswick.
Ragged spruce gall adelgid *Pineus similis* (Gill.)	Black spruce Red spruce	Region	Light shoot damage at scattered locations in Nova Scotia and Prince Edward Island. No reports from New Brunswick.
Red flag of balsam fir *Fusicoccum abietinum* (Hartig) Prill. & Delacr.	Balsam fir	N.S.	Common in western and central Nova Scotia, moderate along roadsides with one or two flags per tree.
Redheaded jack pine sawfly *Neodiprion virginiana complex*	Jack pine Scots pine	Region	No reports in 1989.
Red pine cone beetle *Conophthorus resinosae* Hopk.	Red pine	Region	Found on one small red pine tree at Masstown, Colchester Co., Nova Scotia. No reports from New Brunswick or Prince Edward Island.
Red spruce adelgid *Pineus floccus* (Patch)	Black spruce Red spruce	Region	No reports in 1989.
Resin flow	White spruce	P.E.I.	A continuing problem on the underside of white spruce branches in southern Kings Co. Cause unknown.
Roadside salt damage	Conifers Hardwoods	Region	Foliage discoloration, mostly of white pine and red pine, severe or moderate on roadside trees throughout the Region. Dieback of hardwoods common along the Trans Canada Highway, especially noted from Wentworth Valley, Cumberland Co., to Folly Lake, Colchester Co., Nova Scotia.
Saddled prominent *Heterocampa guttivitta* (Wlk.)	Beech White birch	Region	Defoliation of white birch light at one location in Gloucester Co., New Brunswick and trace on beech in Queens and Digby Counties, Nova Scotia. No reports from Prince Edward Island.
Satin moth *Leucoma salicis* (L.)	Carolina poplar Silver poplar Trembling aspen	Region	Populations contine to decrease in New Brunswick, only trace defoliation of silver poplar at St. Leonard, Madawaska Co., where defoliation was severe in 1988. Populations increased in Nova Scotia, causing defoliation at several locations in Annapolis, Antigonish, Lunenburg, and Richmond Counties. In Prince Edward Island, severe and moderate defoliation of poplars in many areas.
Snow damage	Conifers	Region	Scattered throughout Region, usually little damage; but at Little South Tracadie River, Gloucester Co., New Brunswick, stems of 24% of 3-5 m high jack pine trees were broken; and

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
			and 28% of red pine trees were damaged at Little River, Cumberland Co., Nova Scotia.
Spearmarked black moth *Rheumaptera hastata* (L.)	Trembling aspen White birch Wire birch Yellow birch	N.B. N.S.	Populations increased greatly in New Brunswick and were highest on white birch in the northern half of the Province, an average of 11% of white birch foliage was brown on 69% of the trees, the most serious browning observed at Bald Peak, Victoria Co., 45% of the leaves on all trees were affected. Only one larva found in Nova Scotia.
Spittlebugs *Aphrophora* sp. *Cercopidae*	Conifers Red oak Red maple White birch	Region	Population generally low in the Region, the highest observed at Little River, Colchester Co., Nova Scotia, where 44% of balsam fir trees were affected.
Spotted tussock moth *Lophocampa maculata* Harr.	Alder	N.B.	Few larvae at scattered locations.
Spring cankerworm *Paleacrita vernata* (Peck)	White birch	Region	At endemic levels.
Spruce bud midge *Rhabdophaga swainei* Felt	Black spruce Red spruce White spruce	Region	Populations low but widespread throughout.
Spruce bud scale *Physokermes piceae* (Sch.)	Black spruce Red spruce White spruce	Region	Present at generally low populations at widely scattered locations in the Region, except in New Brunswick: moderate at Bartibog, Northumberland Co., where 44% of branches were infested on 60% of black spruce in a seed orchard in Albert County; in Nova Scotia: moderate at Trafalgar, Guysborough Co., where 43% of black spruce branches were affected; in Prince Edward Island: moderate at Foxley River, Prince Co., where 44% of white spruce branches were infested on 50% of trees.
Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun.	Jack pine White spruce	Region	Populations generally low in Region. See under: Seed orchard pests.
Spruce gall adelgid *Adelges lariciatus* (Patch)	Spruce White spruce	Region	Population low.
Spruce micro moth *Coleotechnites atrupictella* (Dietz)	White spruce	P.E.I.	A few larvae found in Queens and Prince Counties.
Spruce twig aphid *Mindarus obliquus* (Cholod)	Red spruce White spruce	Region	Still widespread in Nova Scotia but less damage than in 1988. Average of 5% of shoots affected at 18 locations (highest 39% on red spruce at Lake Paul, Kings Co.), Prince Edward Island, average of 5% of shoots affected on 37% of white spruce (highest 13% on 50% of trees west of Brackley, Queens Co.). No reports from New Brunswick.
Sugar maple borer *Glycobius speciosus* (Say)	Sugar maple	Region	Present in many sugar maple stands in the Region. In New Brunswick, 24% of trees affected at Petit Paquetville, Gloucester Co.; in Nova Scotia, 8% of trees infested near Moose River, Cumberland Co.; in Prince

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
			Edward Island, one affected tree at Valley-field, Kings Co.
Sulphur dioxide damage	Conifers Hardwoods	N.B.	Trees continue to deteriorate in a plantation and in natural stands near Brunswick Mines, Gloucester County.
Tar spot of maple *Rhytisma acerinum* (Pers. ex St. Amans) Fr.	Maple	N.B. N.S.	Present at scattered locations but more common in Nova Scotia, where an average of 36% of red maple foliage at 19 locations (highest 97% of red maple leaves at both Middle Beaver Lake, Halifax Co. and Jordan Falls, Shelburne Co.).
Uglynest caterpillar *Archips cerasivorana* (Fitch)	Cherry	Region	Still common in all three provinces. In New Brunswick, found at more locations but at lower populations than in 1988; in Nova Scotia, the highest nest counts were in the Truro area of Colchester Co.; in Prince Edward Island, remains widespread but less common.
Wax filament scale *Xylococculus betulae* (Perg.)	Beech White birch Yellow birch	Region	Present throughout New Brunswick on white birch and yellow birch, infesting an average of 35% of white birch at 19 locations; the highest count of 92% of white birch infested was at Point Lepreau, Saint John Co. In Nova Scotia, infestation levels varied on beech and white birch, averaging 36% at 9 locations; the highest count of 76% of beech infested was at Corberrie, Digby Co. No reports from Prince Edward Island.
Weevil damage *Strophosoma melanogrammum* Forst.	Balsam fir Black spruce Red maple Red pine Red spruce White birch	N.S.	No damage found in the red pine plantation in Cape Breton Co., N.S., where severe defoliation occurred on 2-0 trees in May 1988, the first time economically significant damage was caused by this general feeder. Weevils were found on a variety of hosts in widespread areas but no damage was observed.
White pine blister rust *Cronartium ribicola* J.C. Fisch.	White pine	Region	Present throughout the Region; 28% of trees affected at St. Margarets, Northumberland Co., with an average of 11% of trees infected at eight locations in New Brunswick.
White pine cone beetle *Conophthorus coniperda* (Sz.)	Red pine White pine	Region	No reports in 1989.
White pine sawfly *Neodiprion pinetum* Nort.	White pine	Region	Population low throughout; light defoliation occurred on a few plantation trees in Prince Co., Prince Edward Island.
White pine weevil *Pissodes strobi* (Peck)	Black spruce Red spruce White spruce White pine	Region	Present throughout the Region; in New Brunswick, an average of 10% of white pine damaged (15 locations, highest, 36% at Leighton Brook, Northumberland Co.); in Nova Scotia, an average of 12% of white pine trees infested (25 locations, highest, 28% at Jeremy's Bay in Kejimkujik National Park, Queens Co.); in Prince Edward Island, 20% of white pine infested in the Auburn Woodlot, Queens Co.
Whitespotted sawyer beetle *Monochamus scutellatus* (Say)	Balsam fir Black spruce Red spruce White pine White spruce	Region	Common throughout the Region; in New Brunswick, an average of 10% balsam fir infested (18 locations, highest 28% at Innishannon, Gloucester Co.); in Nova Scotia, 22% of white spruce infested at Swallow Hill,

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
			Cumberland Co., and 76% of balsam fir trees had damaged branches from adult feeding at Diligent River, Cumberland Co.; in Prince Edward Island, 40% of balsam fir trees infested near Lorne Valley, Kings Co. and in the Brookdale Demonstration Woodlot, Queens Co.
Willow blight *Venturia saliciperda* Nuesch	Willow	Region	Light shoot and foliage browning at scattered locations in Kent, Restigouche, and Westmorland Counties, New Brunswick; moderate browning on ornamentals at Lyons Brook, Pictou Co., Nova Scotia; and light shoot damage in Kings Co., Prince Edward Island.
Willow flea weevil *Rhynchaenus rufipes* (Lec.)	Balsam poplar Willow	Region	Severe and moderate leaf browning of willow in southeastern New Brunswick, throughout Nova Scotia, and much of Prince Edward Island.
Wind damage	Conifers Hardwoods	Region	Trace to light damage scattered throughout the Region. A small, violent windstorm (twister) in early July in Carlisle, Carleton Co., New Brunswick blew down trees and damaged property. In Nova Scotia, extensive foliage damage and browning occurred on Cape Breton Island and on the northern mainland (see text). In Prince Edward Island, wind-damaged hardwood foliage common throughout, at St. Teresa, Kings Co., 45% sugar maple foliage on 60% of trees affected.
Winter drying	Conifers	Region	In New Brunswick, light and moderate foliage discoloration common on Scots pine Christmas tree plantations in Madawaska and Victoria Counties. In Nova Scotia, foliage discoloration severe on red pine at Pleasant Harbour, Halifax Co., and moderate on black spruce at Maggie Brook, Victoria Co.; trace and light damage common elsewhere in both provinces. No reports from Prince Edward Island.
Winter moth *Operophtera brumata* (L.)	Apple Red oak	Region	Moderate and light defoliation in an old apple orchard at New Minas, Kings Co., present on ornamental trees at Truro, Colchester Co., Nova Scotia, and a few larvae found on red oak at Milton, Queens Co., Prince Edward Island. Numerous moths observed in October and November at Truro, Colchester Co., Stellarton, Pictou Co., and Guysborough Intervale, Guysborough Co. No reports from New Brunswick.
Witches' broom of balsam fir *Melampsorella caryphllacearum* Schroet.	Balsam fir	Region	Widespread in New Brunswick but not common or numerous at any particular location. Present on scattered trees at 33 locations in 13 counties in Nova Scotia. In Prince Edward Island, an average of 14% of trees had brooms (five locations), 28% of the trees with brooms at Brookvale, Queens County.
Witches' broom of spruce *Chrysomyxa arctostaphyll* Diet.	Black spruce	Region	No reports in 1989.

INSECT OR DISEASE	HOST(S)	LOCALITY	REMARKS
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	Black spruce Red spruce White spruce	Region	In New Brunswick, severe or moderate defoliation of a few trees in a black spruce plantation at Londonderry, Kings Co.; only light defoliation at Lisson Settlement, Kings Co., where moderate defoliation occurred in 1988. In Nova Scotia, defoliation severe on a single tree at Lewis Lake, Halifax Co., and moderate on a few trees at Yankeetown, Halifax Co. On Prince Edward Island, severe or moderate defoliation of 20% of black spruce in a 2-ha plantation at Conway, Prince Co.

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LIST OF PUBLICATIONS

Reports and publications by the staff of the Forest Insect and Disease Survey and forest pest related articles by other members of Forestry Canada-Maritimes Region produced in 1989. Contributions without direct FIDS staff involvement are marked by *.

COX, R.M., MAGASI, L.P., and SPAVOLD-TIMS, J. 1989. Deterioration of coastal white birches in relation to their chemical and physical climate. *In* Man and his Ecosystem, Vol. 2, Proc. 8th World Clean Air Congress, The Hague, 11-15 Sept. 1989. *pp.* 243-250.

CORMIER, J.R. 1989. Forest insects and diseases in Kouchibouguac National Park in 1988. FC-M Technical Note 207.

DOANE, A.S. 1989. Forest insects and diseases in Kejimkujik National Park in 1988. FC-M Technical Note 204.

DOBSON, C.M.B. 1989. Forest insects and diseases in Prince Edward Island National Park in 1988. FC-M Technical Note 203.

HARRISON, K.J. 1989. Understanding abiotic problems in managed stands and plantations. FC-M Technical Note No. 208.

HARRISON, K.J. 1989. Ornamental trees and abiotic injury; a guide for the tree owner. FC-M Technical Note 209.

LECKIE, D.G., OSTAFF, D.P., TEILLET, P.M., and FEDOSEJEVS, G. 1989. Spectral characteristics of tree components of balsam fir and spruce damaged by spruce budworm. For. Sci. 35(2): 582-600.

*MACLEAN, D.A. 1988. Effects of spruce budworm outbreaks on vegetation, structure, and succession of balsam fir forests on Cape Breton Island, Canada. *In* Plant form and vegetation structure, *edited by* M.J.A. Werger, P.J.M. van der Aart, H.J. During, and J.T.A. Verboeven, *pp.* 253-161. SPB Academic Publishing, The Hague, The Netherlands.

MACLEAN, D.A., and OSTAFF, D.P. 1989. Patterns of mortality caused by an uncontrolled spruce budworm outbreak on Cape Breton Island, Nova Scotia. Can. J. For. Res. 19: 1087-1095.

MAGASI, L.P. 1989. Forest pest conditions in the Maritimes in 1988. FC - M Information Report M-X-174.

MAGASI, L.P. 1989. White birch deterioration in the Bay of Fundy Region, New Brunswick 1979-1988. FC - M Information Report M-X-175.

MAGASI, L.P. 1989. Highlights of forest pest conditions in the Maritimes in mid-June 1989. FC-M Technical Note 217.

MAGASI, L.P. 1989. Highlights of forest pest conditions in the Maritimes at the end of June 1989. FC-M Technical Note 218.

MAGASI, L.P. 1989. Highlights of forest pest conditions in the Maritimes at the end of July 1989. FC-M Technical Note 220.

MAGASI, L.P. 1989. Monitoring programs associated with other environmental issues in the Region: Forestry. *In* Proceedings of the International Joint Commission, Air Quality Advisory Board, First regional workshop on integrated transboundary monitoring. St. Andrews, New Brunswick, 31 May-2 June, 1988. *pp.* 63-77.

MAGASI, L.P. 1989. Maritimes Region ARNEWS Plots. *In* D'Eon, S.P. and Power, J.M. 1989. The acid rain national early warning system (ARNEWS) plot network. PNFI Info. Rept. PI-X-91.

MAGASI, L.P. 1989. Highlights of forest pest conditions in the Maritimes in mid-September 1989. FC-M Technical Note 221.

MAGASI, L.P., SIMPSON, R.A., and JONES, A.M. 1989. Multi-agency plantation pest surveys in New Brunswick in 1988. FC-M Technical Note 210.

MAGASI, L.P., SIMPSON, R.A., and JONES, A.M. 1989. Multi-agency plantation pest surveys in Nova Scotia in 1988. FC-M Technical Note 211.

MEIKLE, O. A. 1989. Forest insects and diseases in Fundy National Park in 1988. FC-M Technical Note 206.

OSTAFF, D.P., and MACLEAN, D.A. 1989. Spruce budworm populations, defoliation, and change in stand condition during an uncontrolled spruce budworm outbreak on Cape Breton Island, Nova Scotia. Can. J. For. Res. 19: 1077-1086.

QUINN, J.P., PENDREL, B.A., STEWART, J.V., and MURRAY, T. 1989. Controlling the seedling debarking weevil: an economic analysis. FC-M Technical Note 202.

*RENAULT, T.R., and EMBREE, D.G. 1989. Control of mound ants in plantations. FC-M Technical Note 219.

WALSH, T. 1989. Forest insects and diseases in Cape Breton Highlands National Park in 1988. FC-M Technical Note 205.